# ANNUAL REPORT

# FOREST PEST CONDITIONS IN WISCONSIN

## 1968

WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FORESTRY AND RECREATION
BUREAU OF FOREST MANAGEMENT

FOREST PEST SURVEY AND CONTROL

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# PREFACE

The year 1968 was much like previous years as to the variety of interesting problems that were encountered. A few new ones such as an outbreak of pink-striped oakworm and Adelopus needle cast on Douglas fir came to the attention of the Forest Pest Survey and Control Section, as new ones do each year, and old familiar pests continue to interfere with timber production. We are hopeful that more effort can be expended in the near future on major persistent problems such as the jack pine budworm. The outlook is encouraging.

Our thanks to the many individuals who participated with us in our activities and provided support when it was needed, especially personnel in the Bureau of Forest Management and other bureaus of the department.

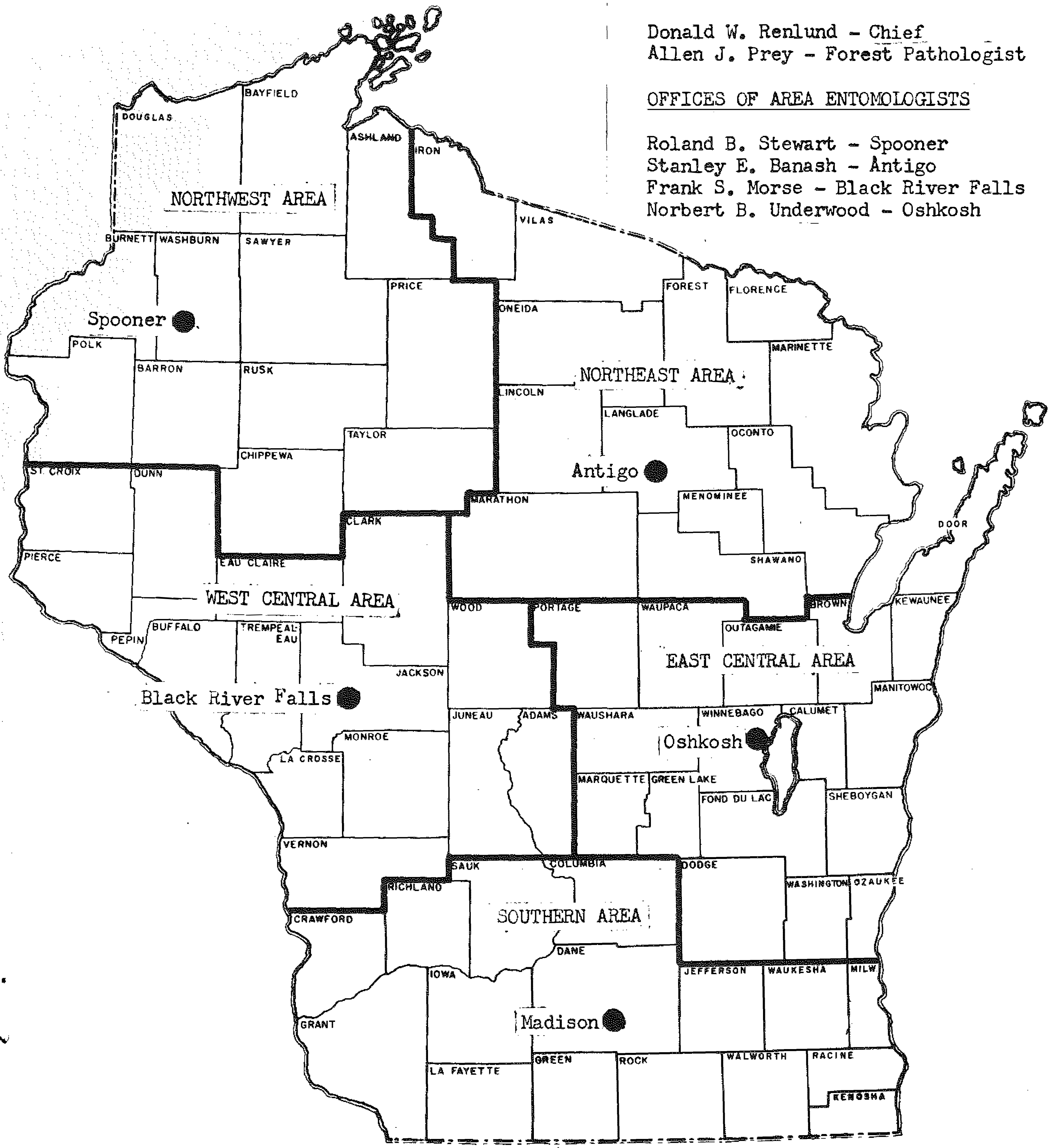
Donald W. Renlund
Chief, Forest Pest Survey and Control

FOREST PEST SURVEY AND CONTROL
HEADQUARTERS AND SOUTHERN AREA OFFICE
Nevin Hatchery, Madison

Donald W. Renlund - Chief
Allen J. Prey - Forest Pathologist

OFFICES OF AREA ENTOMOLOGISTS

Roland B. Stewart - Spooner
Stanley E. Banash - Antigo
Frank S. Morse - Black River Falls
Norbert B. Underwood - Oshkosh


BAYFIELD
DOUGLAS
ASHLAND
IRON
NORTHWEST AREA
VILAS
BURNETT
WASHBURN
SAWYER
PRICE
FOREST
FLORENCE
Spooner
ONEIDA
POLK
MARINETTE
BARRON
RUSK
NORTHEAST AREA
LINCOLN
LANGLADE
TAYLOR
OCONTO
CHIPPEWA
ST. CROIX
DUNN
Antigo
MARATHON
MENOMINEE
CLARK
DOOR
PIERCE
EAU CLAIRE
SHAWANO
WEST CENTRAL AREA
WOOD
PORTAGE
WAUPACA
BROWN
KEWAUNEE
BUFFALO
TREMPEALEAU
OUTAGAMIE
PEPIN
EAST CENTRAL AREA
JACKSON
MANITOWOC
Black River Falls
JUNEAU
ADAMS
WAUSHARA
WINNEBAGO
CALUMET
MONROE
Oshkosh
LA CROSSE
MARQUETTE
GREEN LAKE
FOND DU LAC
SHEBOYGAN
VERNON
SAUK
COLUMBIA
DODGE
RICHLAND
WASHINGTON
OZAUKEE
CRAWFORD
SOUTHERN AREA
DANE
IOWA
JEFFERSON
WAUKESHA
MILW
GRANT
Madison
LA FAYETTE
GREEN
ROCK
WALWORTH
RACINE
KENOSHA

## HIGHLIGHTS

Following is a brief summary of forest insect and disease conditions encountered during the year. More details concerning items mentioned and others may be found in appropriate sections of the report.

... Jack-pine budworm populations in northwestern Wisconsin counties dwindled to endemic levels during the spring forcing drastic alterations in plans to field-test insecticides. Prolonged cold wet weather during larval development, a build-up of parasites and predators, and unknown factors combined to reduce the availability of suitable test sites thereby limiting the number of compounds that could be tested.

Dylox, Gardona and Matacil were applied by aircraft. Results were disappointing because of rapidly deteriorating test conditions. Matacil provided the best control with an inadequate population reduction of 42%. Accothion and Landrin were omitted from the tests because of limited availability of test sites and lack of previous experience with the insecticides.

Budworm populations remained active in central, north central and northeastern jack pine areas. Operational chemical control will not be attempted until a suitable insecticide is available. Meanwhile, prompt harvest of severely defoliated and highly susceptible useful timber is encouraged to reduce waste and to reduce the potential for budworm build-up.

... Pine tussock moth eggs were numerous west of Wascott (Douglas County) in T42N and T43N, R13W. Browning of foliage was evident after feeding by newly-hatched larvae.

... Defoliation of beech and hard maple by the saddled-prominent caterpillar continued on Rock Island (Door County).

... The pink-striped oakworm completely defoliated approximately 400 acres of scrub northern pin oak west of Gordon near Bardon Lake in Douglas County. This is the first documented outbreak by this insect in Wisconsin.

... Scrub oak was severely defoliated in the Town of Stephenson, Marinette County, by the fruit-tree leaf roller.

... The oak skeletonizer was active in Monroe and Juneau Counties where defoliation was conspicuous along ridges in July.

... Spring and fall cankerworms were abundant at Sister Bay in Door County.

... A single colony of forest tent caterpillars was found in Douglas County and a single larva in Adams County. No eggs were found in the annual survey.

... White pine weevil populations were higher in the Northwest Area than they have been for several years. Populations were lower in other areas.

... The pine root weevil continues to be a major pest of jack pine in the West Central Area.

... Reports indicated that red-pine needle midge activity was more widespread in the state than in 1967.

... Pine spittlebug infestations were severe in localized areas and some Scotch pine Christmas tree plantations required treatment.

... Treatment of 1,522 acres of red pine plantations was recommended to landowners in the Northeast Area for control of the Saratoga spittlebug.

... Sawflies caused little serious defoliation on larch or pines anywhere in the state.

... Extensive surveys during 1968 verified the presence of the native elm bark beetle in 10 new counties and the smaller European elm bark beetle in one new county.

... Six new counties were added to the list of those in which Dutch elm disease is known to occur.

... Balsam fir needle rust caused browning of balsam foliage in Lincoln and Oneida Counties. Natural stands and plantations were affected.

... Adelopus needle cast (Swiss needle cast) was found on Douglas fir Christmas trees in Kewaunee County. This was the first report of the disease in Wisconsin. It has caused damage in the New England States and Europe.

... Brown spot needle blight was a serious problem on Scotch pine Christmas trees in Jackson and Trempealeau Counties.

... Austrian pine needle blight continues to damage its host Christmas trees.

... Work started on white pine blight in 1967 continued. Tobacco plants, sensitive to atmospheric oxidants, were used to determine periods of infection.

... _Fomes annosus_ root rot has not been found in Wisconsin.

... Black walnut root rot at Boscobel Nursery was investigated.

... There was no change in the statewide distribution of oak wilt.

... Anthracnose was common on white and bur oak.

... Winter injury was widespread on junipers.

## MAJOR FOREST INSECTS

### COLEOPTERA

Bronze Birch Borer - Agrilus anxius Gory

This insect was active in shade and ornamental white birch trees throughout the Northwest Area. Tree mortality was reported in Spooner (Washburn County) and around Clam Lake in Burnett County. A number of infested ornamental white birch were observed in the Madison area (Dane County).

Two-Lined Chestnut Borer - Agrilus bilineatus (Weber)

Several pockets of scrub oak mortality, attributed to the borer, were located in the Town of Stephenson (Marinette County). Characteristic "D"-shaped emergence holes were numerous in trunks of dead trees over an area which has been repeatedly defoliated by walkingsticks and post-oak grasshoppers (T32N, R18E).

No additional areas of tree mortality were recorded in West Central Area locations where the borer had been active in 1967. Some trees died in these and other previously reported areas, but evidence of the insect and its activity was generally much less apparent.

Pales Weevil - Hylobius pales (Herbst)

Spring feeding by adult weevils damaged Scotch and red pine seedlings in areas where Christmas trees had been harvested in Adams County. Many Christmas tree growers in the West Central Area have reduced pales weevil problems by their efforts to control the root collar weevil.

Damage was observed at scattered locations in Portage, Waupaca, Waushara, and Marquette Counties on twigs of Scotch pine. Some mortality occurred to seedlings in Waushara County fields where trees had been harvested the previous fall.

Pine Root Collar Weevil - Hylobius radicis Buchanan

While the insect continues to be a serious pest in Northwest Area Christmas tree plantations, no new infestations were found in forest plantings.

Few new infestations were reported in the West Central Area but most untreated Scotch pine stands are infested. Many red and jack pine plantations are infested to varying degrees but rarely as heavily as the Scotch pine.

Scotch, red and jack pine continue to be attacked in the East Central Area in the order of preference listed. Scotch pine are being removed where they constitute a hazard to adjacent red pine. Most weevil attacks are in windbreak trees and are common in Marquette County (Sections 8, 9, and 32, T17N, R10E) and Waushara County (SE¼ Section 33, T18N, R10E).

Pine Root Weevil - Hylobius rhizophagus Millers

No new infestations were reported in the Northwest Area, but flagging and tree mortality was observed in localities of known infestations in Polk, Burnett, and Washburn Counties. About 10% of the small reproduction was killed by the weevil in a Washburn County plantation (Section 19, T42N, R12W) in 1968.

Infestations continue to destroy sapling-size jack pine plantations in the West Central Area where the weevil is a major pest of jack pine. Damage is becoming very noticeable in several Jackson County forest plantations.

Populations have declined in two areas - one in Waushara County (NESW Section 13, T19N, R10E) and one in Marquette County (Section 5, T16N, R 8 E) following removal of infested Scotch pine several years ago.

Native Elm Bark Beetle - Hylurgopinus rufipes (Eichhoff)

Extensive surveys conducted during 1968 indicated the beetle is present in most counties in Wisconsin but its presence is yet to be verified in a few. (See map on page 25). The insect was found in all Northeast Area counties where it appears to be the primary vector of Dutch elm disease in forest stands. It was the only elm bark beetle collected from elm slash in timber sale areas and from diseased trees in Jackson County.

An intensified study of the beetle distribution and habits in forest elm stands was started in Menominee County during the year, and will be continued in 1969. A report on observations and data collected is made part of this report and starts on page 38.

Pine Bark Beetles - Ips spp.

Few instances of damage by bark beetles were reported anywhere in the state during the year in which generally good moisture conditions prevailed in the state. Second generation beetles moved into a jack pine planting in Bayfield County (Section 32, T46N, R9W) and killed about 1% of the residual trees following a non-commercial thinning which had been completed early in the spring.

Several small pockets of dead trees were found in a 30-acre pine plantation in Marinette County (Section 32, T35N, R21E). The 10' to 18' tall trees appeared to have died following bark beetle attacks in 1967. No evidence was observed of beetle attacks in the stand during the 1968 season.

Beetles managed to kill a few jack pine in timber sale areas early in the dry spring in the West Central Area, but populations were reduced during the wet summer weather and no later damage was observed.

Phenological Notes:

| | | |
|---|---|---|
| August | 14. - | Evidence of initial attacks on pulpwood cut on July 15 in Sauk County and piled near the stand. |
| September | 12 - | Teneral adults and pupae were found in the red pine pulpwood piles in Sauk County. |

June Beetles - Phyllophaga spp.

Heavy flights of adults were observed in Antigo (Langlade County) and Mountain (Oconto County) on June 10. Aspen, birch and maple were the favored hosts. Severe defoliation of oak occurred in the Town of Stephenson (Marinette County) in an area where jack pine and scrub oak are major components of the forest type.

Little defoliation of hardwoods or damage to new pine plantings was apparent in the northwest counties where adults were numerous, but their emergence was prolonged over a six-week period which started May 1 in the vicinity of Spooner.

Similarly, beetle emergence and flights were prolonged in west central counties by variable weather. No white grub damage to seedlings was reported in the West Central Area.

Northern-Pine Weevil - Pissodes approximatus Hopkins

Observed damage by this insect was confined to young red pine plantings which had been afflicted with needle-droop and winter injury. Infestations occurred mostly in depressions or frost pockets and were reported only from the Northwest Area.

White-Pine Weevil - Pissodes strobi (Peck)

Northwest Area - Populations were higher than they have been for several years. However, while infested leaders were noted throughout the area, no individual stands were severely damaged. No stands had more than one or two percent of the leaders infested, and white, jack and Scotch pine appeared to be about equally affected.

Northeast Area - Only a few infested white pine and Norway spruce terminals were observed throughout the area where populations remained low.

West Central Area - Populations remained low in most plantations, although up to 15% of the leaders were infested in some open plantings.

East Central Area - Populations have remained at a low level for three years, and infested trees are rare in the area. Plantation owners have been encouraged to remove infested leaders as they are encountered to maintain the low incidence of infestation.

Pityogenes sp.

Minute beetles in this genus were associated with red pine flagging which had been attributed to winter injury and Saratoga spittlebug. Heavy flagging was noted in Sections 25 and 30, T36N, R18E (Grandfather Lake plantations) and Section 5, T35N, R19E (Phillipsburg plantations) in Marinette County. Beetles, apparently in the same genus, were associated with flagged 1967 growth on 30% of the red pine in a young plantation in SWSE of Section 26, T46N, R10W (Douglas County).

Phenological Notes:

May 14 - Beetles were collected in the Douglas County plantation.

June 11 - Beetles were collected from dead and dying branches in Marinette County.

Smaller European Elm Bark Beetle - Scolytus multistriatus (Marsham)

A detection survey to establish the northern limits of the distribution of this beetle in Wisconsin resulted in the finding of a single adult beetle in one new location near the southern boundary of Oconto County in Section 1, T28N, R18E. A map of known beetle distribution in the state may be found on page 25 in the section on tree diseases.

DIPTERA

Balsam Gall Midge - Dasyneura balsamicola (Lintner)

Moderate infestation of a Christmas tree planting occurred in Section 15, T39N, R13W (Washburn County) again this year.

High-value balsam fir Christmas tree plantations were heavily infested in Langlade, Shawano, Oneida and Lincoln Counties. Infested trees were from 4 to 10 feet tall, and infestations were most severe on the shaded east exposures adjacent to hardwood stands. Many of the plantation owners treated their trees with mistblower applications of malathion or methoxychlor.

Following are locations where major infestations were noted:

| | |
|---|---|
| Langlade County | Sections 6, 17, T31N, R12E<br>Section 23, T30N, R12E<br>Section 5, T30N, R11E |
| Lincoln County | Section 13, T33N, R7E |
| Shawano County | Section 28, T28N, R12E |

Phenological Notes:

May 6 - Balsam buds beginning to open. Some frost damage occurred.

May 10 - Balsam shoots elongated 1/16 to 1/2 inch.

May 15 - Balsam shoots about 1 inch long. First adult midges caught in traps at Phlox (Langlade County).

Red Pine Needle Midge - Thecodiplosis piniresinosae Kearby

Infested red pine were observed at numerous locations in the northern two-thirds of the state.

Infestations were generally light in many red pine stands in Adams, Clark, Eau Claire, Jackson, Juneau, Trempealeau and Wood Counties, where only a few needles per twig were injured.

Fifty to seventy percent defoliation occurred in an Adams County plantation in Quincy Township (Section 18, T16N, R5E) during August. This was early for damage to appear and midge larvae were small. High mortality of infested needles and presumably to immature larvae was attributed principally to a high midge population and periods of high temperatures. Temperatures in the area reached more than ninety degrees Fahrenheit every day from Tuesday through Friday during the week which ended August 23. The high temperature in the area for the week was 96° F. and the low averaged 49 degrees. The average temperature in the area was 77° F. for the week compared with the 30-year norm of 70 degrees.

A light infestation was observed on scattered trees on the north side of Shell Lake (Washburn County) and light to moderate infestations were noted on current-year needles in Marinette, Oneida and Vilas Counties.

Phenological Note:

September 25 - Midge larvae in needles at Boulder Junction (Vilas County, Sections 19, 20, 29, T42N, R7E).

HOMOPTERA

Spruce Gall Aphids - *Adelges cooleyi* Gillette

*Chermes abietis* Linnaeus

Numerous reports of infested spruce trees were received in the East Central and Southern Areas.

Pine Spittlebug - *Aphrophora parallela* (Say)

Spittle masses were much in evidence throughout Northwest Area counties. The most heavily infested jack pine stands were in T40N, R11W, and T42N, R13W (Washburn County), and T43N, R13W, T44N, R10 and 11W, and T45N, R10 and 11W (Douglas County). The upper parts of jack pine stems were completely white with spittle masses in many stands in the descriptions listed.

Infested stands of Scotch pine Christmas trees were common throughout the counties of the Northeast Area where the infestations were the worst ever experienced. Spittle masses were so large and numerous in some plantations that the trees had the appearance of being snow covered. The most severe infestations occurred in the following locations:

| | |
|---|---|
| Langlade County - | NE¼NE¼ Section 15, T33N, R13E, 40 acres, all heavily infested, Scotch pine 6' to 9' tall. |
| | Section 16, T34N, R12E, several small plantings, all heavily infested, Scotch pine. |
| | SENW Section 20, T33N, R11E, 30 acres, all heavily infested. Severe flagging on 1967 growth, Scotch pine. |
| Shawano County - | SWNE Section 8, T28N, R12E, 35 acres, all heavily infested sheared Scotch pine. |

Many growers resorted to chemical control to protect their trees, applying insecticide with mistblowers or aircraft. Neither water nor oil formulations of malathion or methoxychlor, or mixtures of the two insecticides provided satisfactory control of the nymphs enveloped in spittle. The greatest population reduction in the nymphal stage was 70%. However, technical malathion applied undiluted at the rate of 16 fluid ounces per acre, by aircraft, provided up to 99% reduction of the insects once they reached the adult stage.

Scotch pine Christmas tree plantations in the east and west central counties were also infested, but to a much lesser degree, and massive coats of spittle were rarely observed except in a few Waupaca County plantations.

Ten acres of Scotch pine Christmas trees near Lone Rock (Sauk County) were treated on July 2 to protect them from further damage. High populations in 1967 had killed much of that year's growth rendering the trees unsalable, and heavy infestations threatened them with further damage in 1968.

Phenological Notes:

May 20 - Nymphs were in the 1st instar in northwest counties.

May 22 - 95% of eggs had hatched in Shawano County. Scotch pine shoots averaged one inch long.

May 29 - Nymphs 5th instar on jack pine in Dane County. 20% of Scotch pine shoots were infested with 1 to 5 nymphs per shoot on trees 5 feet to 8 feet tall near Lone Rock (Sauk County).

June 3 - 80% of the nymphs were in the 2nd instar on Scotch pine in Langlade County.

June 10 - Spittle masses conspicuous on jack pine in Bayfield and Douglas Counties. 85% of the nymphs were in the 3d instar on Scotch pine in Shawano County where chemical treatments were started.
Spittle masses were drying, nymphs were in the process of transforming to adults in Dane County.

June 12 - Nymphs in the 3d instar in Oconto County where Scotch pine Christmas trees averaged 2.5 nymphs per spittle mass and 9 masses per tree.

June 13 - Two out of seventy nymphs emerged as adults in a Dane County sample.

June 18 - 15% of nymphs in 4th instar, 85% in 5th in Langlade County.

June 20 - 10% of nymphs in 3d instar, 50% in the 4th, and 40% in the 5th in a Langlade County plantation. The 4th instar was predominant in Oneida County, and nymphal development in Shawano County lagged behind that of Oneida County about a week. 50% of the nymphs had transformed to adult stage in Sauk County near Lone Rock.

July 10 - Spittle was dripping from pulpwood size jack and Scotch pine near Boulder Junction in Vilas County.

July 11 - 95% of the nymphs were in the 5th instar in Shawano County.

July 18 - 95% of pine spittlebugs in adult stage in Shawano County, mating pairs observed.

Saratoga Spittlebug - Aphrophora saratogensis (Fitch)

Populations increased in some stands in northwestern counties. Flagging due to spittlebug feeding was noted in Section 25, T46N, R10W and Section 1, T45N, R10W (Douglas County) and severe flagging was reported in Section 26, T42N, R8W, and Sections 2 and 3, T41N, R8W (Sawyer County).

Heavy infestations and severe flagging were reported in many young red pine plantations in Marinette, Oneida and Vilas Counties in the northeast. Ten plots in an Oneida County plantation, SW¼ Section 36, T37N, R9E each had more than ten nymphs. Populations were high enough on 1,522 acres of red pine plantations in the Northeast Area to warrant treatment. Landowners treated 259 acres with mistblowers and the remainder by aerial application of insecticides.

Small areas of damage by this insect were reported in scattered private and county plantations in Clark, Jackson and Monroe Counties, but no chemical control was attempted.

Infestations were reported in two East Central Area counties where they were associated with perched water tables, pot holes, and other poorly drained sites. Locations reported were NWSW Section 12, T25N, R10E (Portage County), and NE¼ Section 2 and 3, T25N, R15E and N½NE Section 23, T24N, R12E (Waupaca County).

One plantation owner attempted to kill newly hatched nymphs by a topical application of DDT to the ground surface prior to egg hatching (April 25), but no discernible difference was apparent between treated and nearby untreated areas. An emulsifiable concentrate was used at the rate of one pound per acre. Adult spittlebugs were plentiful at the time of emergence but their numbers declined very noticeably in both treated and untreated areas about a week later following a driving rain that did not appear to be of sufficient intensity or duration to have effected the population reduction.

Phenological Notes:

May 1 - Eggs had hatched on white and red pine in Oconto County.

May 16 - 10% to 15% of the spittlebug eggs had hatched in red pine buds in Vilas County (SW¼ Section 36, T37N, R9E). Buds had elongated up to 1/4".

June 18 - Nymphs were in the 3d instar in Vilas and Oneida Counties.

June 20 - Last instar in Clark County and 3d in Langlade County.

Balsam Twig Aphid - Mindarus abietinus Koch

A heavy infestation was reported on balsam fir in a plantation in Section 1, T16N, R8E (Marquette County). Sooty mold blackened the trees rendering them unmarketable for Christmas trees. Unidentified two-spotted lady beetles and neuropterans were present on the infested trees.

A suspected infestation was reported from Monroe County (SENW¼, Section 35, T18N, R2W). Twigs and small branches were blackened by sooty mold on some trees and new growth was stunted and curled, but the insects were not observed on the samples submitted.

Pine Bark Aphid - Pineus strobi (Hartig)

Populations were endemic at Boscobel and Hayward nurseries and no treatment was applied. Lindane was used at Hugo Sauer to maintain aphid-free trees. Eggs were observed in Wood County on April 30 and crawlers had settled on new shoots of white pine in Sauk County on May 17.

Pine Tortoise Scale - Toumeyella numismaticum (Pettit & McDaniel)

Two heavy infestations were reported on jack pine in the Northeast Area. A thirty-year-old plantation in Florence County and a natural stand of cut-over jack pine near Caldron Falls (Marinette County) were severely attacked. Heavy infestations were also reported in Scotch pine Christmas tree plantings in Oconto, Oneida, and Langlade Counties. Several growers in these counties treated their trees with malathion during the shearing season.

The scale was a nuisance in Scotch pine Christmas tree plantations in Clark, Jackson, Monroe, and Trempealeau Counties. The population appeared to be declining in Section 26, T19N, R1E (Monroe County) where a few small trees were killed by scale in 1967, but no new crawlers were found in 1968.

A few infested trees were found throughout the jack pine type and on scattered Scotch pine over the rest of the state.

Phenological Notes:

June 13 - Eggs were hatching on jack and Scotch pine in Adams County.

June 14 - Eggs were just starting to hatch on natural jack pine in Jackson County near Millston.

June 20 - First crawlers of the season observed in Langlade County were in Section 14, T34N, R12E.

HYMENOPTERA

Introduced Pine Sawfly - Diprion similis (Hartig)

Spring populations caused little noticeable defoliation, as usual, in the northwest counties. Fall populations were higher and larvae continued feeding into early October, but no reports of serious defoliation were received.

First generation larvae caused heavy defoliation of a few ornamental white pines in Clark County, but little defoliation occurred elsewhere in the West Central Area. Empty cocoons were found on red pine in a windbreak along Wisconsin highway 25 north of Interstate 94 (NWNW Section 13, T30N, R12W Dunn County).

Cocoons of a sawfly believed to be D. similis were collected in Outagamie County (T23N, R19E) on March 9. No emergence occurred so the identification has not been confirmed. The sawfly is rarely found in the county named.

Red-Headed Pine Sawfly - Neodiprion lecontei (Fitch)

A few colonies were found on ornamental jack pine trees in the community of Shell Lake (Washburn County), and occasionally colonies were found at widely scattered locations over the rest of the state as populations continued to remain at non-damaging levels. Near-mature larvae were collected from a single, isolated, heavily infested small jack pine in an open area near the southwest corner of the junction of Wisconsin highway 54 and County Trunk A in Portage County on July 24.

Red-Pine Sawfly - Neodiprion nanulus nanulus Schedl

The only colonies observed or reported were a few on ornamental red pines in Shell Lake (Washburn County), a few lightly infested natural jack pine in a wayside along U. S. Highway 14 near Gotham (Richland County), and a single small colony on red pine at Boscobel in Grant County. The larvae at Boscobel were one inch long on May 29.

White-Pine Sawfly - Neodiprion pinetum (Norton)

Two large white pine were severely defoliated in Section 7, T15N, R9E, in Marquette County, and near mature larvae were observed on eight-foot-tall white pine near Sheboygan on August 1.

Jack-Pine Sawfly - Neodiprion pratti banksianae Rohwer

None reported in Wisconsin during 1968.

Larch Sawfly - Pristophora erichsonii (Hartig)

Northwest Area - Defoliation was spotty throughout the area and only a few small areas of tamarack were severely defoliated. High water tables and predators caused destruction of many cocoons.

Northeast Area - Defoliation varied from none to severe in several counties. The most severe defoliation was noted in a few stands in Langlade, Oneida, and Vilas Counties.

West Central Area - Light defoliation occurred in many tamarack stands in Clark, Jackson, and Wood Counties, but generally defoliation was not as severe as in the last few years.

## LEPIDOPTERA

### Cankerworms

Fall Cankerworm - Alsophila pometaria (Harris)
Spring Cankerworm - Paleacrita vernata (Peck)

Reports of defoliation indicated that infestations were spotty and generally less severe than in recent previous years. The spring cankerworm was observed on Rock Island (Door County) feeding in company with the saddled prominent caterpillar in an area of saddled prominent infestation on June 20. Both species of cankerworms were abundant at Sister Bay (NWNW Section 6, T31N, R28E) in Door County on the same date.

### Fruit-Tree Leaf Roller - Archips argyrospilus (Walker)

This insect was common on oaks in parts of Bayfield and Douglas Counties, but caused no noticeable defoliation in 1968.

Severe defoliation of scrub oak in the Town of Stephenson, Marinette County, was widespread in T32N, R18E. The area defoliated has had a history of repeated attacks by other insects. Larvae were in the late instars, and some were pupating on June 11 when the oak leaves were about 3/4 full size.

### Large Aspen Tortrix - Archips conflictana (Walker)

Larvae were still readily found in many aspen stands in Ashland, Price, Rusk, Taylor, and parts of Bayfield and Douglas Counties but defoliation was very light.

No defoliation was observed in the West Central Area.

### Oak Webworm - Archips fervidanus (Clemens)

Nests were very common on scrub oak in T43N, R13W and T45N, R11W and larvae were numerous in other parts of Douglas County. Late larval and pupal parasites of this insect were the same as those which are commonly associated with the jack pine budworm and pine tussock moth.

### Pink-Striped Oak Worm - Anisota virginiensis (Drury)

The first known extensive defoliation by this insect in Wisconsin occurred near Bardon and other lakes west of Gordon in Douglas County during the summer of 1968. Approximately 400 acres of scrub northern pin oak were completely defoliated in an area that covered parts of Sections 15, 16, 21 and 22, T43N, R12W. The stand of oak was of no commercial value, but likely of high esthetic value to the owners of lakeshore cabins in the midst of the infestation. Larvae were near mature and very numerous in the leafless trees and on the ground when the area was visited on July 31. Many of the larvae perished from starvation and other causes before they completed their development.

Oak Skeletonizer - Bucculatrix ainsliella Murtfeldt

Many acres of oak were browned and partially defoliated in Monroe and Juneau Counties by this skeletonizer. Damage was most conspicuous along ridge tops in July. Cocoons were noted in many other counties, especially Adams, Clark, Jackson, La Crosse, Vernon and Wood, indicating a potential increase in area of noticeable defoliation for 1969.

Birch Skeletonizer - Bucculatrix canadensisella Chambers

Early browning and defoliation of white birch, caused by this skeletonizer, occurred in Monroe and Vernon Counties.

Jack-Pine Budworm - Choristoneura pinus (Freeman)

Northwest Area

Severe defoliation of Northwest Area jack pine stands in 1967 left few suitable feeding sites for young larvae and resulted in lower early-instar larval counts in 1968. Second instar larvae left hibernacula about mid-May but persistent cold, cloudy, wet weather impeded their feeding. Later larval development was also slow and erratic as similar weather continued throughout the growing season.

Parasites were abundant in most infested jack pine stands in the northwest counties, with Apanteles wasps taking the greatest toll of budworm larvae. Late-instar larval counts were down throughout the Northwest Area and only a few isolated stands showed noticeable browning due to budworm feeding. Further evidence of the budworm population decline to endemic levels were low pupal and egg-mass counts over the entire area.

Tree mortality, principally due to bark beetle attacks on top-killed trees, continued in stands severely defoliated in 1967.

Many severely defoliated stands in Burnett, Douglas and Bayfield Counties were assigned high cutting priorities and harvested. Unfavorable market conditions temporarily hindered some landowners in the removal of budworm-defoliated jack pine from afflicted areas, but pessimism was displaced by optimism as marketability of timber improved toward the end of 1968.

Northeast Area

Defoliation ranging in intensity from light to heavy occurred on 19,900 acres of jack pine timber in the Northeast Area. Acreage affected, by counties, was as follows:

| County | Acreage |
|---|---|
| Oconto | 1,200 |
| Oneida | 2,800 |
| Vilas | |
| Boulder Junction | 2,800 |
| Conover vicinity | 6,700 |
| Marinette | 6,400 |
| Total | 19,900 acres |

Locations of infested areas are depicted on county maps on pages 20, 21, 22, and 23.

Severe defoliation occurred for the first time in recent years (since 1956-57) near Lake Nokomis and Hazelhurst in Oneida County; in the vicinity of Thunder Lake and Caldron Falls in Marinette County; and near Stormy Lake and Lac Vieux Desert in Vilas County. Severe defoliation was apparent in stands near Boulder Junction for the second consecutive year, and near Conover for the third year. The last two communities named are in western and east central Vilas County respectively. Defoliation was generally most severe on large mature trees, and jack pine timber on a 120-acre area near Conover that was defoliated in 1967, was killed. High mortality also occurred in a younger adjacent plantation. Top-killing is anticipated in stands most heavily defoliated.

Much of the damaged jack pine on state and county lands has been cut, and routine timber sales are expected to provide for orderly removal and utilization of remaining damaged trees.

West Central Area

Budworm populations were higher during 1968 than previous years in jack pine stands in Adams, Jackson, Juneau, Monroe, and Wood Counties. Heavy defoliation occurred on approximately 3,000 acres in Juneau County. Light to medium defoliation (light browning and thinned foliage) occurred on 5,000 to 6,000 additional acres in Juneau County; 1,000 to 1,500 acres in Adams County; 4,000 acres in Jackson County; and 1,500 to 2,000 acres in Wood County. Total light defoliation in the West Central Area is estimated at 12,000 to 13,000 acres.

Some top killing and loss of reproduction may occur in the area of heavy defoliation, but good moisture conditions and the young, vigorous condition of the stands are expected to keep tree loss to a minimum.

Egg surveys indicated lower budworm populations will occur in most of the infested areas in 1969, but medium defoliation may be expected in parts of four additional townships in southeast Wood County and northern Adams County.

No apparent budworm defoliation occurred in jack pine stands in other areas.

Phenological Notes:

May 13 - Budworm larvae out of hibernation in Burnett and Washburn Counties. Jack pine leaders 3" to 6" long, pollen flowers large and yellow-green.

May 14 - Budworm larvae out of hibernation in Douglas and Bayfield Counties. Jack pine leaders 1" to 2½" long on young trees, pollen flowers green and hard.

May 16 - Jack pine shoots 1" long and no 2nd instar larvae found in Vilas County trees examined.

May 22 - Larvae still small 2nd instar in Washburn and Burnett Counties. Jack pine leaders 3" to 10" long. Pollen ripe and mostly disseminated. Third instar larvae in Adams, Jackson and Juneau Counties.

June 3 - Larvae still small 2nd instar in Douglas and Bayfield Counties. Jack pine leaders 3" to 6" long and pollen ripe, being shed.

June 5 - Larvae starting to feed in western Douglas County. Some 3d instar larvae found. Pollen gone.

June 6 - Jack pine terminals 1" to 4" long. Budworm larvae 80% in 2nd instar and 20% in the 3d. Third instar larvae were feeding in staminate flowers in Vilas County. Most larvae in the 4th and a few in the 5th instar in Juneau County.

June 11 - Budworm larvae mostly in the 3d instar and a few in the 4th in staminate flowers in Vilas County. Thirty per cent in 4th instar, 50% in 5th and 20% in 6th instar in Jackson County.

June 12 - Twenty per cent in 4th instar, 50% in 5th and 30% in 6th and 2 pupae in Adams, Wood and Juneau Counties.

June 13 - Larvae ranged from 2nd through 4th instars in Sawyer and eastern Washburn Counties.

June 17 - First pupae on Scotch pine in Adams County; about 60% in 5th instar, rest in 4th and 6th instars.

June 18 - Larvae in 3d, 4th, and 5th instars in Washburn County. First Apanteles cocoon found for the season.

June 20 - Larvae pupating in Jackson County.

July 1 - First pupae of the season observed in Douglas County.

July 2 - Most larvae in the late 4th or early 5th instars, feeding on old needles in Vilas County.

July 7 - About 17% of larvae pupated in Vilas County.

July 10 - Thirty per cent of larvae pupated in western Douglas County and about 50% in Washburn County.

July 11 - About 10% of larvae had pupated in northern Douglas and Bayfield Counties. Moths had emerged from most pupae observed near Necedah (Juneau County) and most eggs had hatched in one egg mass.

July 16 - Pupation completed in Polk and Burnett Counties and some moths emerged.

July 24 - Budworm moth emergence complete in Douglas County.

August 2-6 - Moths were numerous in Douglas County. Relatively few egg masses found, some still green, most masses hatched.

Pine Tussock Moth - Dasychira plagiata (Walker)

Anticipated tussock moth populations failed to materialize in T44N, R11W (Douglas County) where larvae and subsequent egg masses were both scarce during the 1968 season.

West of Wascott, however, larvae were numerous throughout the summer in T42N and T43N, R13W along the Douglas-Washburn County line. Egg counts in the townships increased over those of 1967 and browning of foliage was evident following feeding by newly-hatched larvae prior to going into hibernation. Unless overwintering larval mortality is high, moderate to severe defoliation will occur on an area of approximately 3,000 acres.

Although the insect has rarely been observed in the West Central Area, several egg masses were found in a localized area in Adams County (SWSW Section 26, T19N, R5E) during jack-pine budworm pupal and egg mass surveys.

Phenological Notes:

April 20 - Larvae started emerging from hibernation in Douglas County.

April 22 - Larvae feeding slowly. Jack pine leaders 1½" long, Pasque flowers blooming in Douglas County.

April 30 - Some 3d instar larvae in Douglas County.

July 15 - Pupal stage predominant in T43N, R13W.

July 17 - Egg masses and moths in Adams County (SWSW Section 26, T19N, R5E). No hatched eggs.

July 26 - First moths, but no eggs found in Douglas County.

July 29 - Mating pairs of moths and numerous egg masses in Douglas County.

August 13 - Eggs hatching in Douglas County.

August 19 - Most of eggs hatched, new tussock moth larvae starting to feed.

August 29 - Most of larvae in hibernation, some browning of foliage apparent from larval feeding prior to hibernation.

Eastern Tent Caterpillar - Malacosoma americanum (Fabricius)

A few tents were found on wild cherry along roadsides in Washburn and Burnett Counties, and a few were observed in the west central counties.

Forest Tent Caterpillar - Malacosoma disstria (Hubner)

A single colony of about 30 near-mature larvae was observed on Populus tremuluoides in Douglas County (Section 6*, T45N, R10W) on June 13. No noticeable defoliation was evident in the cluster of aspen.

A single larva was found in Section 15, T19N, R6E in Adams County.

No egg masses were found in the annual winter egg mass survey.

*Section 10 NW¼ in the November 8, 1968 Situation Report should have been Section 6.

Jack-Pine Shoot-Borer - Eucosma somomana Kearfott

Moderate to heavy infestations were observed in jack pine reproduction where an industrial forest site had been disked to promote natural regeneration. Approximately half of the attacks were in leaders resulting in forked trees. The damage was noted in parts of Section 20 and 30, T36N, R6E in Oneida County.

Populations remained at endemic levels in Scotch and jack pine stands in the West Central Area. The insect was not reported from other areas.

Zimmerman Moth - Dioryctria zimmermani (Grote)

Heavy infestations continued in red and Scotch pine Christmas tree and windbreak plantings in the Wisconsin River Valley near Boscobel in Grant County.

The insect was also reported in Scotch pine Christmas tree plantations in Juneau and Trempealeau Counties where it caused insignificant damage.

A granular systemic insecticide, 2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl) oxime, also known as Temik, was applied to the ground surface with a rotary-disc applicator at rates of 2 and 3 pounds of active ingredient per acre to red pine plots on May 16, 1968 at Boscobel State Nursery. No detectable control of the insect was observed in comparison of counts of infested shoots in treated and check plots.

Saddled Prominent - Heterocampa guttivitta (Walker)

Much of the beech and maple on 900-acre Rock Island (Door County) was defoliated to varying degrees for the second consecutive year. Dieback of beech saplings was evident. Emergence of moths from overwintering pupae was first noted on June 19 and 20. Calosoma beetles, Calosoma scrutator and Calosoma frigidum were observed feeding on the moths and later in the summer, on the larvae.

During a survey of the infested area on August 8 a flurry of activity by the Calosoma beetles occurred following a drenching electrical storm. Prior to the storm activity phalangids were numerous on the boles of infested trees and in the leaf litter, and occasionally Calosoma beetles were observed. Following the storm the beetles seemed to be everywhere.

Numerous dead and dying larvae were found around the bases of large trees, and on the lower boles. Presumably much of the mortality was due to activity of the arthropod predators.

European Pine Shoot Moth - Rhyacionia buoliana (Schiffermuller)

Scarce during 1968.

ORTHOPTERA

Post Oak Locust - Dendrotettix quercus (Packard)

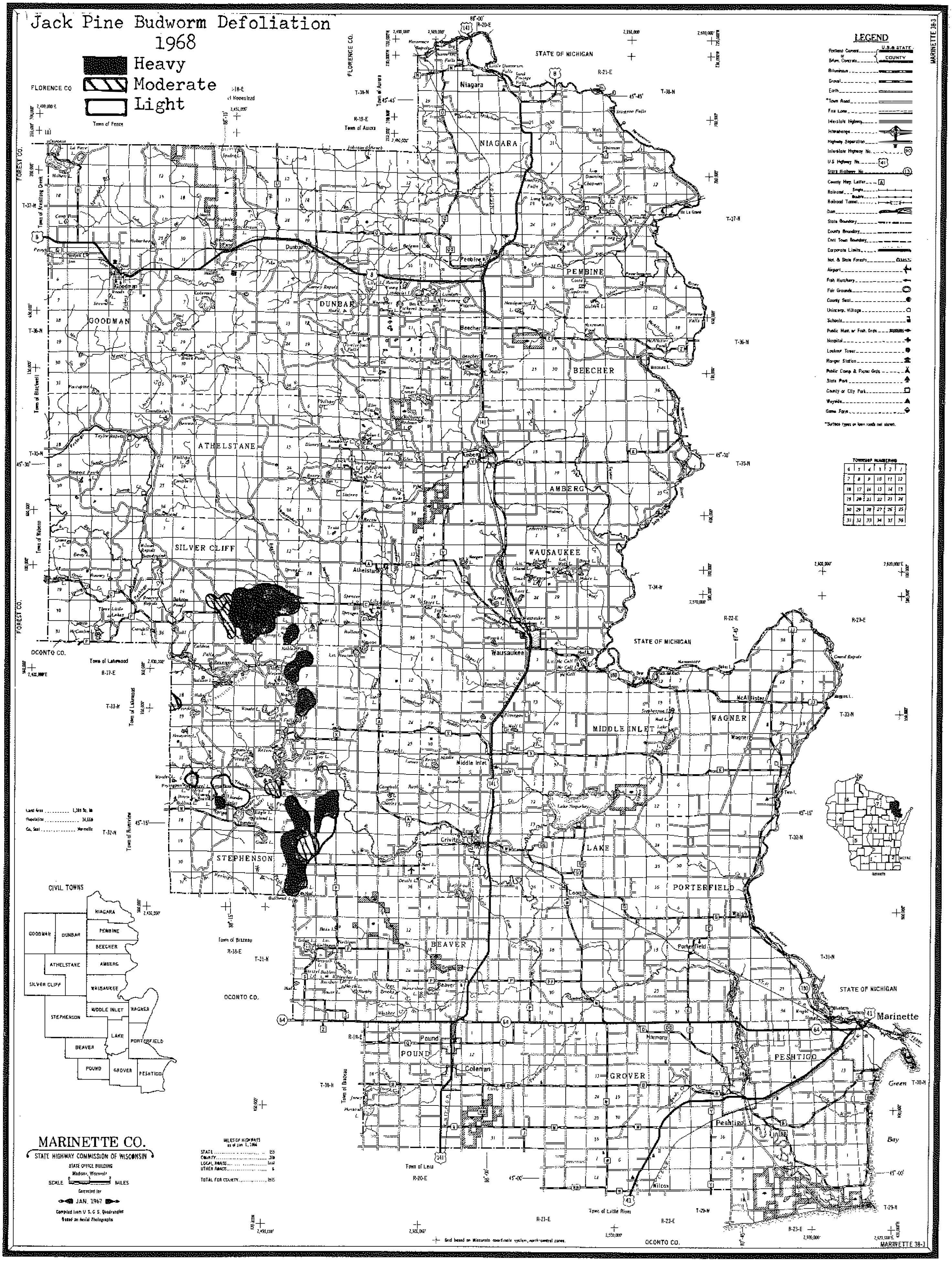
Few of the "grasshoppers" were observed in the West Central Area in 1968 and no defoliation by the insect was reported. D. quercus was inactive in Marinette County.

Walkingstick - Diapheromera femorata (Say)

The insects were numerous in parts of four sections in Douglas County (Sections 29, 30, 31, and 32, T43N, R13W). The population was composed of more than 90% males, and the females did not mature until September. Feeding was confined almost entirely to hazel.

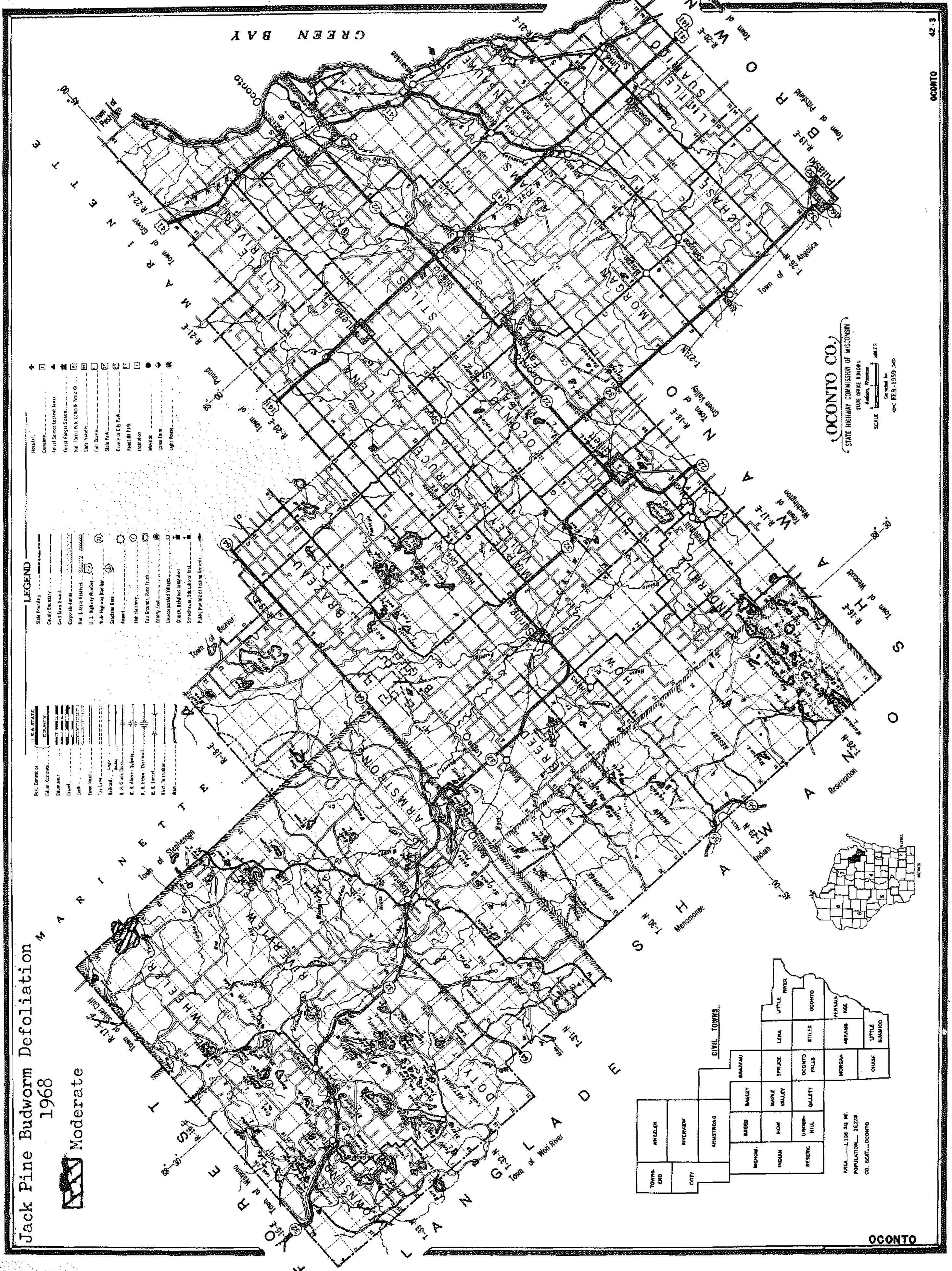
Defoliation was severe on 2,500 acres of scrub oak in the Town of Silver Cliff in Marinette County where the insects have been known to be active in even years since 1952. Although the boundaries of the area infested by these "even-year" walkingsticks has varied little over the years, noticeable population fluctuations have occurred within the area.

Walkingsticks were rarely observed in the West Central Area and no defoliation was reported.



Jack Pine Budworm Defoliation 1968

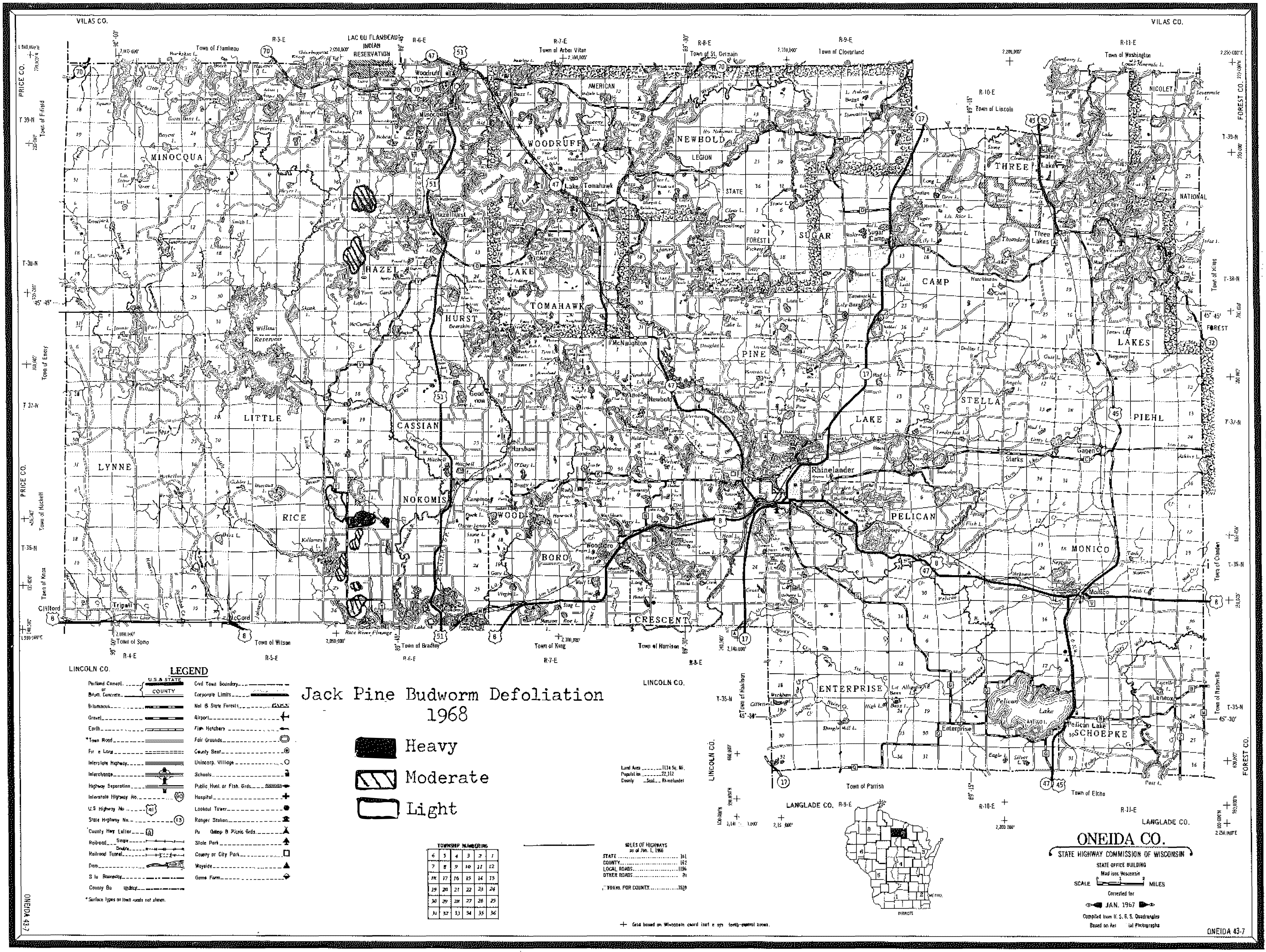
▨ Heavy
▧ Moderate
☐ Light
MARINETTE CO.
STATE HIGHWAY COMMISSION OF WISCONSIN
STATE OFFICE BUILDING
Madison, Wisconsin
SCALE MILES
Corrected to JAN. 1967
Compiled from U.S.G.S. Quadrangles
Based on Aerial Photographs
LEGEND
CIVIL TOWNS
NIAGARA
PEMBINE
DUNBAR
GOODMAN
BEECHER
ATHELSTANE
AMBERG
SILVER CLIFF
WAUSAUKEE
STEPHENSON
MIDDLE INLET
WAGNER
LAKE
PORTERFIELD
BEAVER
POUND
GROVER
PESHTIGO
STATE OF MICHIGAN
FLORENCE CO.
FOREST CO.
OCONTO CO.
Marinette
Green Bay
Crivitz
Wausaukee
Niagara
Pembine
Amberg
Athelstane
Middle Inlet
Coleman
Peshtigo
Pound
Beaver
Wagner
Porterfield
MARINETTE 38-3



Jack Pine Budworm Defoliation
1968

▨ Moderate

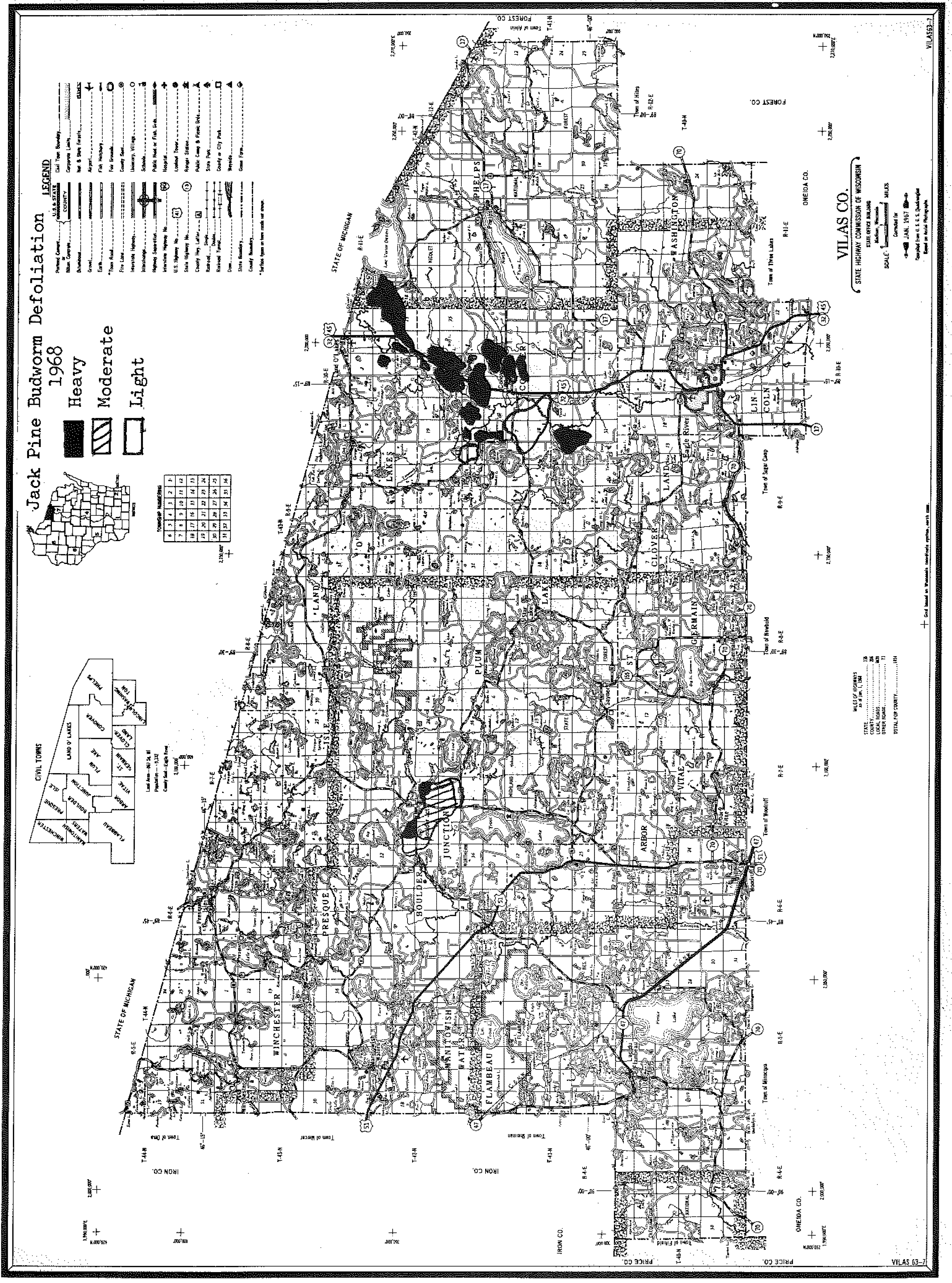
OCONTO CO.
STATE HIGHWAY COMMISSION OF WISCONSIN
STATE OFFICE BUILDING
Madison, Wisconsin
SCALE MILES
Corrected to FEB. 1959
GREEN BAY
MARINETTE
FOREST
LANGLADE
SHAWANO
OCONTO
BROWN
LEGEND
CIVIL TOWNS
WHEELER
RIVERVIEW
ARMSTRONG
BREED
BAGLEY
BRAZEAU
HOW
MAPLE VALLEY
SPRUCE
LENA
LITTLE RIVER
UNDERHILL
GILLETT
OCONTO FALLS
STILES
OCONTO
MORGAN
ABRAMS
PENSAUKEE
CHASE
LITTLE SUAMICO
DOTY
TOWNSEND
AREA.....1,106 SQ. MI.
POPULATION.....25,238
CO. SEAT.....OCONTO
OCONTO
42-3



Jack Pine Budworm Defoliation
1968

- ▩ Heavy
- ▨ Moderate
- ☐ Light

ONEIDA CO.
STATE HIGHWAY COMMISSION OF WISCONSIN
STATE OFFICE BUILDING
Madison, Wisconsin
SCALE
MILES
Corrected for
JAN. 1967
Compiled from U. S. G. S. Quadrangles
Based on Aerial Photographs
ONEIDA 43-7
VILAS CO.
PRICE CO.
FOREST CO.
LINCOLN CO.
LANGLADE CO.
MINOCQUA
WOODRUFF
NEWBOLD
THREE LAKES
HAZELHURST
LAKE TOMAHAWK
SUGAR CAMP
PINE LAKE
STELLA
PIEHL
LITTLE RICE
LYNNE
CASSIAN
NOKOMIS
WOODBORO
CRESCENT
PELICAN
MONICO
ENTERPRISE
SCHOEPKE
Rhinelander
LEGEND
TOWNSHIP NUMBERING
MILES OF HIGHWAYS



Jack Pine Budworm Defoliation 1968

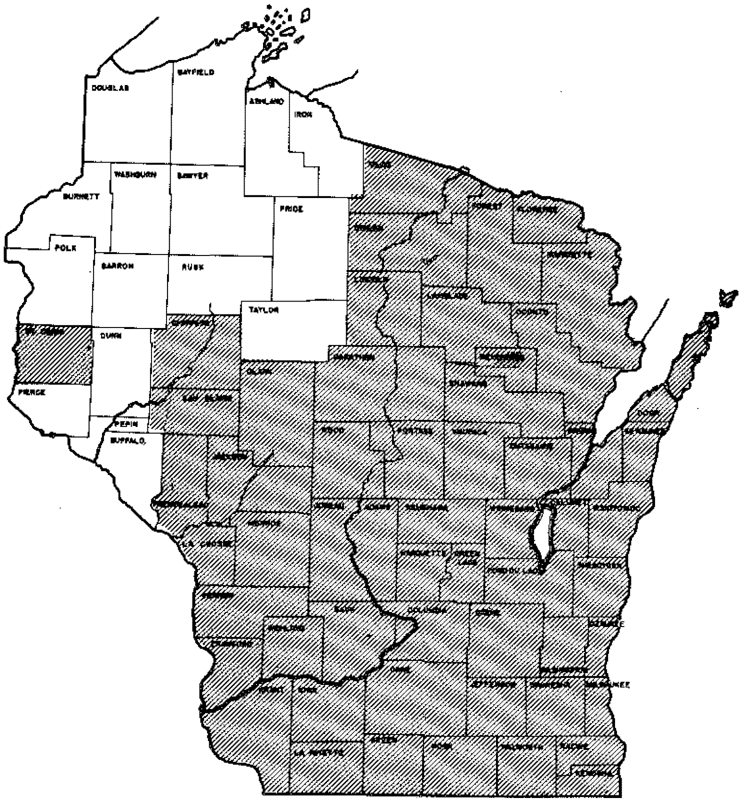
▇ Heavy
▨ Moderate
☐ Light
VILAS CO.
STATE HIGHWAY COMMISSION OF WISCONSIN
LEGEND
CIVIL TOWNS
STATE OF MICHIGAN
IRON CO.
FOREST CO.
ONEIDA CO.
PRICE CO.
PHELPS
WASHINGTON
LINCOLN
CONOVER
LAND O' LAKES
PLUM LAKE
ST. GERMAIN
CLOVER LAND
ARBOR VITAE
BOULDER JUNCTION
PRESQUE ISLE
WINCHESTER
MANITOWISH WATERS
LAC DU FLAMBEAU
VILAS 63-7

# MAJOR FOREST DISEASES

## WILTS AND DIEBACKS

### Dutch Elm Disease - *Ceratocystis ulmi* (Buisman) Moreau

Dutch elm disease has been reported in 56 of Wisconsin's 72 counties (see map below). New counties reported in 1968 were Forest, Florence, St. Croix, Trempealeau, Lincoln and Vilas.


DOUGLAS
BAYFIELD
ASHLAND
IRON
WASHBURN
SAWYER
BURNETT
PRICE
POLK
BARRON
RUSK
TAYLOR
DUNN
PIERCE
PEPIN
BUFFALO
FOREST
LANGLADE
OCONTO
MARATHON
WOOD
PORTAGE
DOOR
LA CROSSE
MARQUETTE
GREEN LAKE
FOND DU LAC
COLUMBIA
DANE
JEFFERSON
MILWAUKEE
LA FAYETTE
GREEN
ROCK
WALWORTH
RACINE
KENOSHA

Known Distribution of
Dutch Elm Disease
1968

A cooperative survey between the Plant Industry Division, Wisconsin Department of Agriculture and the Forest Pest Control Section, Department of Natural Resources updated the known distribution of elm bark beetles in Wisconsin. The last extensive survey was made in 1963. The European elm bark beetle was collected in one new county (Oconto) (Figure 1 page 25), while the native elm bark beetle was found in ten additional counties; Door, Florence, Forest, Iron, Marinette, Oconto, Oneida, Pierce, Rusk and Taylor (Figure 2 page 25 ).

An aerial survey for Dutch elm disease incidence in Menominee County, Wisconsin was conducted on July 24, 1968. A Cessena Skylane was flown at an altitude of 1,000 feet with flight lines one mile apart. Two observers mapped suspect trees (see map on page 26 ) which were later ground checked. In addition Kodachrome II aerial photographs were taken of areas of heavy infestation with a hand held 135 mm camera.

At Devil's Lake State Park (Sauk County) 95 elms were treated with Bidrin in 1967 and 9 were diseased at the end of the growing season. In 1968 the remaining 86 trees were again treated with Bidrin and 17 were infected at the end of the growing season. Thus, 69 (72%) of the 95 original trees remain.

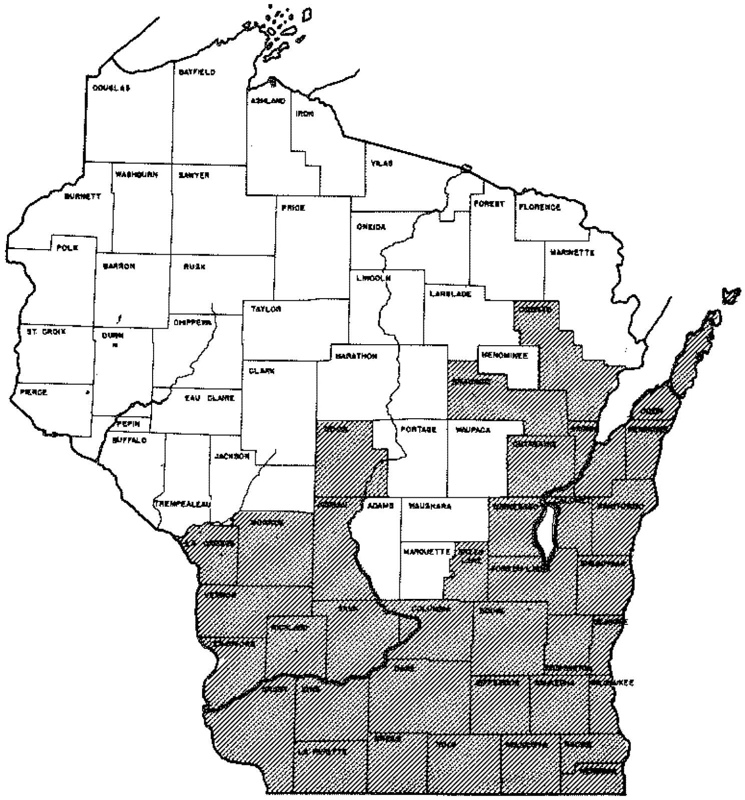

DOUGLAS
BAYFIELD
ASHLAND
IRON
VILAS
WASHBURN
SAWYER
BURNETT
PRICE
ONEIDA
FOREST
FLORENCE
POLK
BARRON
RUSK
MARINETTE
LINCOLN
LANGLADE
TAYLOR
ST. CROIX
DUNN
CHIPPEWA
MARATHON
MENOMINEE
CLARK
PIERCE
EAU CLAIRE
PEPIN
BUFFALO
PORTAGE
WAUPACA
JACKSON
TREMPEALEAU
ADAMS
WAUSHARA
MARQUETTE

Fig. 1 - Known distribution of the European Elm Bark Beetle.

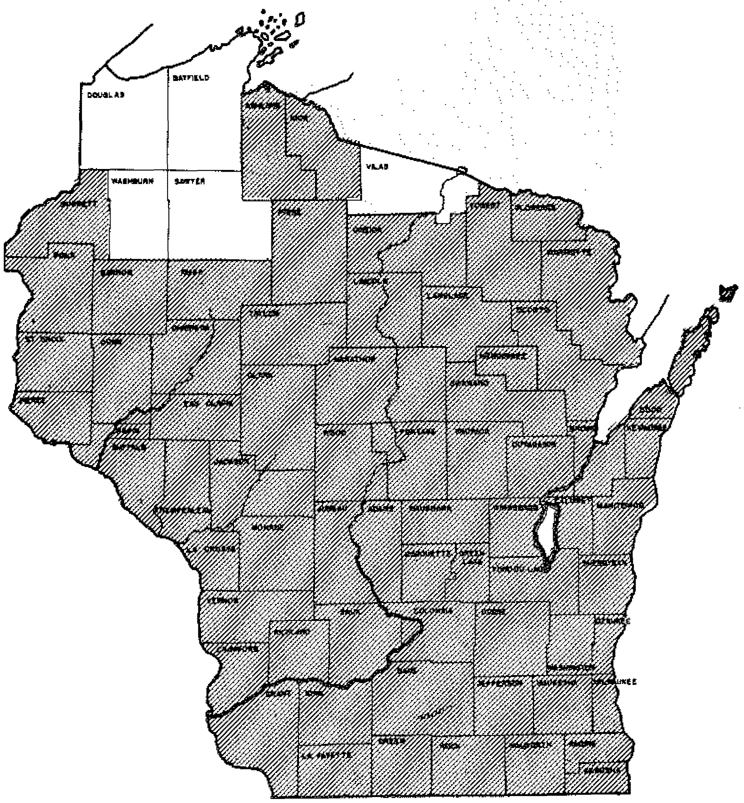
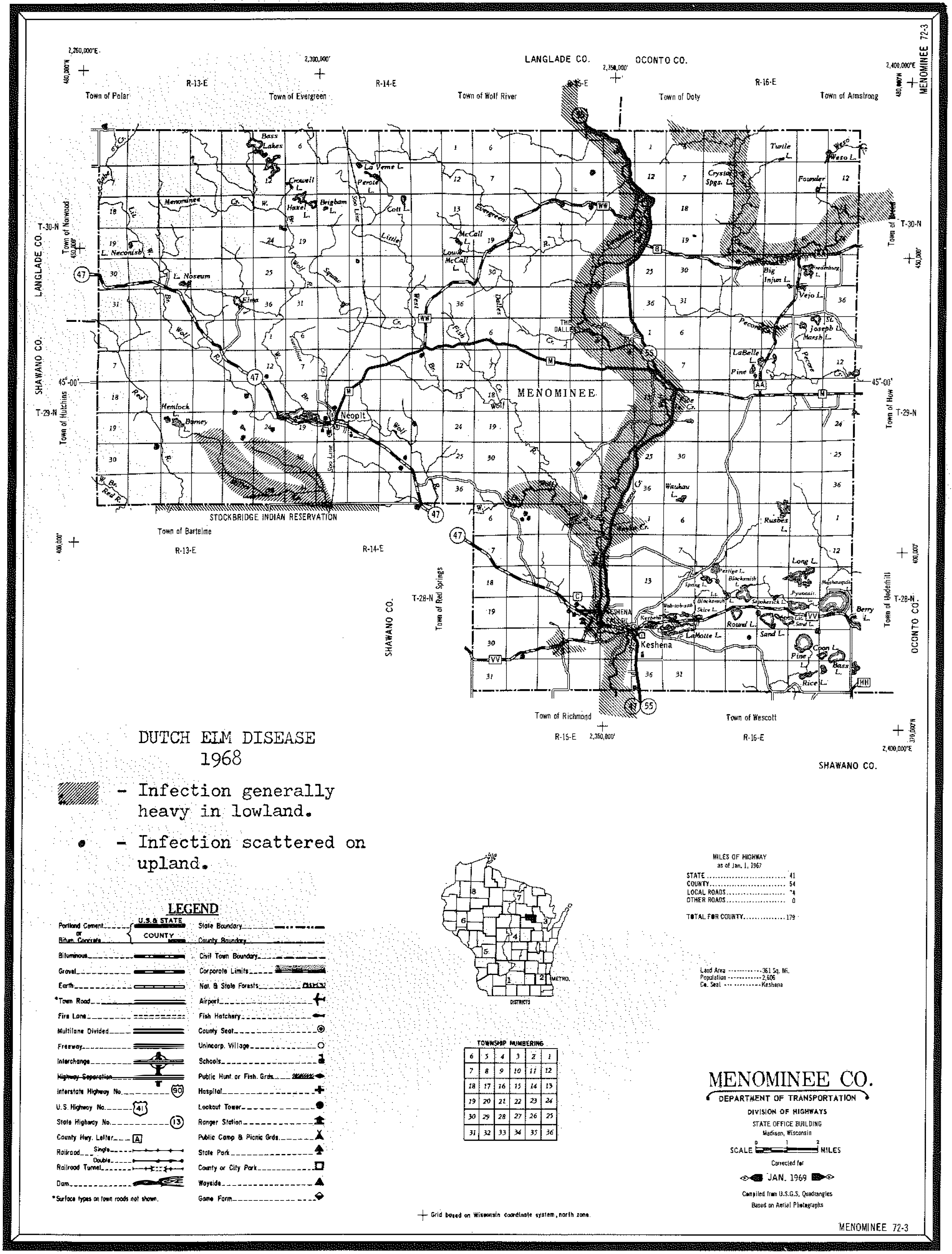

DOUGLAS
BAYFIELD
VILAS
WASHBURN
SAWYER

Fig. 2 - Known distribution of the Native Elm Bark Beetle.


LANGLADE CO.
OCONTO CO.
SHAWANO CO.
MENOMINEE
Neopit
Keshena
STOCKBRIDGE INDIAN RESERVATION
Town of Polar
Town of Evergreen
Town of Wolf River
Town of Doty
Town of Armstrong
Town of Bartelme
Town of Richmond
Town of Wescott
R-13-E
R-14-E
R-15-E
R-16-E
T-28-N
T-29-N
T-30-N
45°-00'
LEGEND
MILES OF HIGHWAY
TOWNSHIP NUMBERING
MENOMINEE CO.
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
STATE OFFICE BUILDING
Madison, Wisconsin
SCALE
MILES
Corrected for
JAN. 1969
Compiled from U.S.G.S. Quadrangles
Based on Aerial Photographs
MENOMINEE 72-3

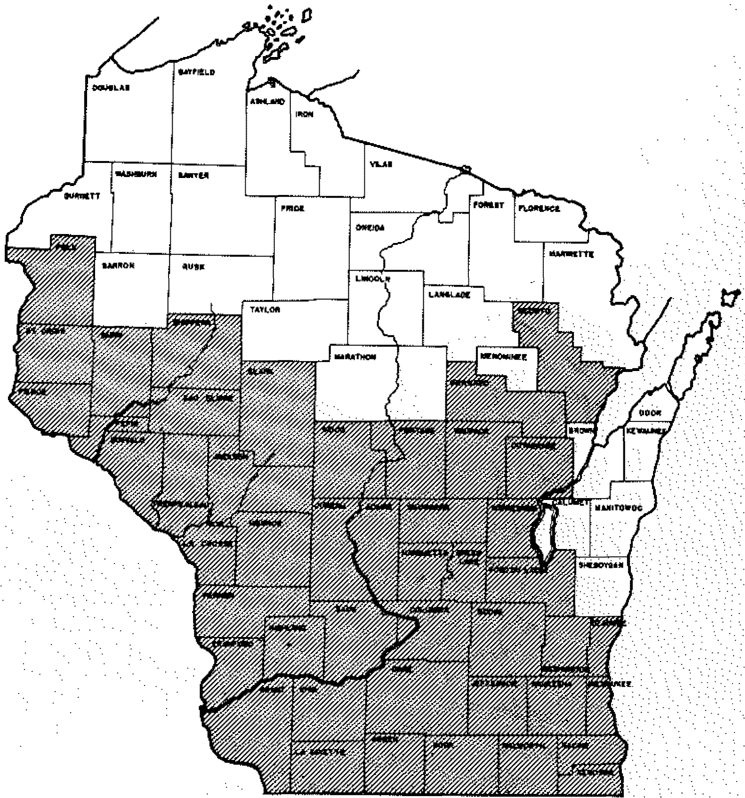
DUTCH ELM DISEASE
1968

▨ - Infection generally heavy in lowland.

● - Infection scattered on upland.

### Oak Wilt - Ceratocystis fagacearum (Bretz) Hunt

There was no change in the statewide distribution of oak wilt in Wisconsin during 1968.


DOUGLAS
BAYFIELD
ASHLAND
IRON
VILAS
BURNETT
WASHBURN
SAWYER
PRICE
ONEIDA
FOREST
FLORENCE
MARINETTE
BARRON
RUSK
LINCOLN
LANGLADE
TAYLOR
MARATHON
MENOMINEE
EAU CLAIRE
DOOR
BROWN
KEWAUNEE
CALUMET
MANITOWOC
SHEBOYGAN
LA CROSSE
MILWAUKEE
LA FAYETTE

Known Distribution of
Oak Wilt
1968

## ROOT ROTS

### Annosus Root Rot - Fomes annosus (Fr.) Cke.

To date Fomes annosus root rot has not been found in Wisconsin. Numerous plantations have been examined statewide in the past six years for the presence of F. annosus sporophores and root systems were examined for decay caused by F. annosus. In every plantation examined the results were negative.

Attempts were made to trap spores of F. annosus in the atmosphere from 1963-1966 using pine foliage and cheesecloth spore traps as collecting devices. The spore collections were then incubated on freshly cut pine discs. Fomes annosus was never detected in any of the spore collections.

## STEM AND BRANCH DISEASES

### PINE GALL RUST

Eastern Gall Rust - Cronartium quercuum (Berk.) Miyabe ex Shirai

Western Gall Rust - Peridermium harknessii J. P. Moore

A survey was conducted in 1967 to determine the distribution of western gall rust in Wisconsin and was reported in the "Annual Report, Forest Pest Conditions in Wisconsin - 1967". A correction should be made in the 1967 Report, page 53 as follows - "Western gall rust was present on Scotch and jack pine ..." and not on red pine as indicated in the report.

A completed survey report was published in March, 1968. The title of the report is:

McGrath, W. T. 1968. Western gall rust in Wisconsin - 1967 Survey. Wisconsin Department of Natural Resources, Madison, 5 p. mimeo.

### Black Walnut Seedling Dieback - Unknown

Top dieback of 2-4" has been observed on field planted black walnut nursery seedlings in southern Wisconsin. Insects and fungi do not appear to be involved and frost is not the cause of the problem.

## FOLIAGE DISEASES

### Anthracnose - Gnomonia sp.

Heavy infection of oak anthracnose on white and bur oak resulted in numerous specimens being sent to the laboratory to be tested for presence of oak wilt.

### Balsam Fir Needle Rust - Uredinopsis spp.

Mid-summer browning of balsam fir foliage was noted in several areas of Langlade and Oneida Counties. Excessive precipitation in late May and the month of June provided ideal conditions for the inoculation of needles with rust spores. Both natural stands and plantations were affected by the disease.

### ADELOPUS NEEDLE CAST

Adelopus (Phaeocryptopus) gaumanni Rohde

Adelopus needle cast or Swiss needle cast was identified on approximately one acre of Douglas fir Christmas trees planted in Kewaunee County near Algoma, Wisconsin (NW¼, Section 23, T25N, R25E).

This is the first report of the disease in Wisconsin. Adelopus needle cast has caused considerable damage to young Douglas fir planted in the New England States and Europe.

## Life Cycle

Collections were made at the Algoma site every two weeks throughout the growing season to record the development of fungus and survey for newly infected trees. The results are as follows; spores were present within perithecia on old needles on the first collection date June 13, 1968 through the 4th collection on July 30, 1968. Perithecia were first observed on current year's needles on September 16, 1968. Similar studies in Connecticut report that in 1938 perithecia were first observed on current year's needles in November.

## Phenological Notes:

1967 - May 27 - Douglas fir buds just opening

1968 - June 13 - Perithecia on 1967 needles, spores within asci. 1968 needles have emerged and some are almost the same length as 1967 needles.

July 2 - Perithecia on 1967 needles, spores within asci. 1968 needles same length as 1967 needles, except on some severely defoliated trees the 1968 needles are small and just emerging from the buds.

July 15 - Perithecia on 1967 needles, spores within asci.

July 30 - Perithecia, but ascospores are limited. One small perithecium with asci containing ascospores.

August 16 - Perithecia on 1967 needles but ascospores lacking.

September 16 - First perithecia on 1968 needles observed at the base of the needles. Also young (small) and old (large) perithecia on 1967 needles.

October 16 - Perithecia on 1968 needles, no spores. Perithecia on 1967 needles, ascospores lacking.

October 29 - Perithecia on 1967 and 1968 needles, no ascospores.

November 19 - Perithecia on 1967 and 1968 needles, no ascospores.

Brown Spot Needle Blight - *Lecanosticta acicola* (Thuem.) Syd.

This needle disease of pine has been previously reported as being present in some Scotch pine plantations in west central Wisconsin. In 1968 an epidemic of *Lecanosticta acicola* was reported on Scotch pine Christmas trees planted in Jackson and Trempealeau Counties. Thousands of Christmas trees were made unmerchantable because of needle browning and casting associated with the fungus infection (Figures 3, 4, and 5).

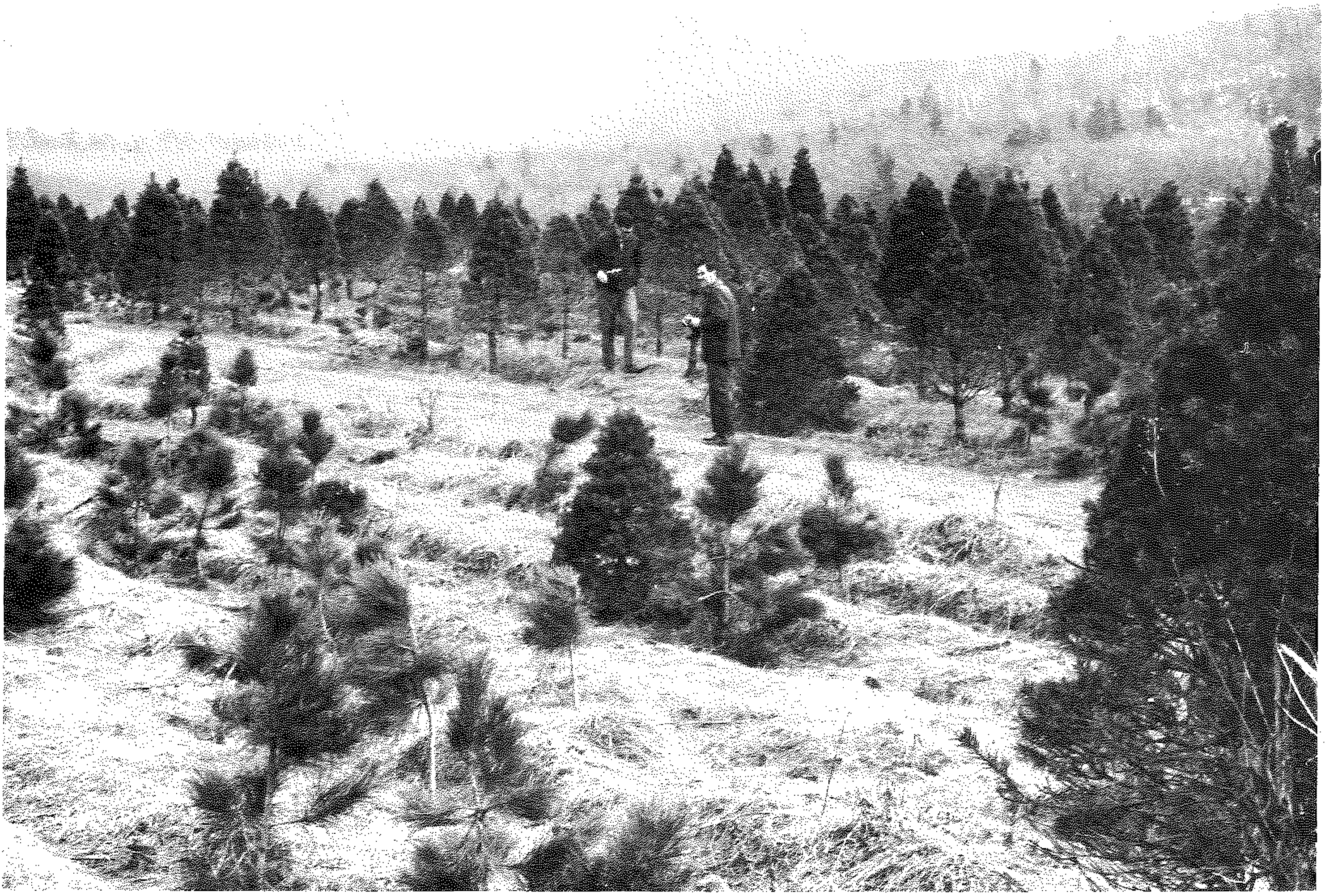


Fig. 3 - A Scotch pine Christmas tree plantation near Black River Falls, Wisconsin that is infected with brown spot needle blight (*Lecanosticta acicola*). Photographed on April 8, 1969.

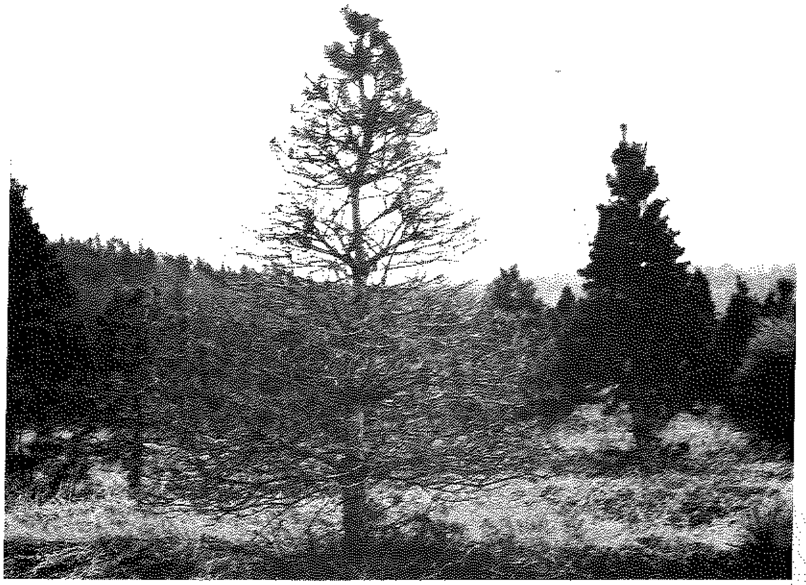


Fig. 4 - A sheared Scotch pine that was unmerchantable because of needle browning and casting caused by brown spot needle blight (Lecanosticta acicola).

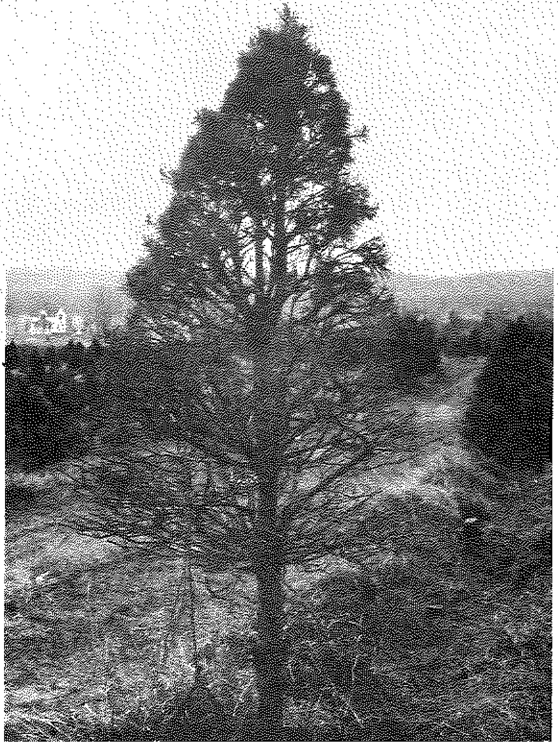


Fig. 5 - The fungus infection is common on needles of the lower branches and is more severe on the north or shady side of the tree.

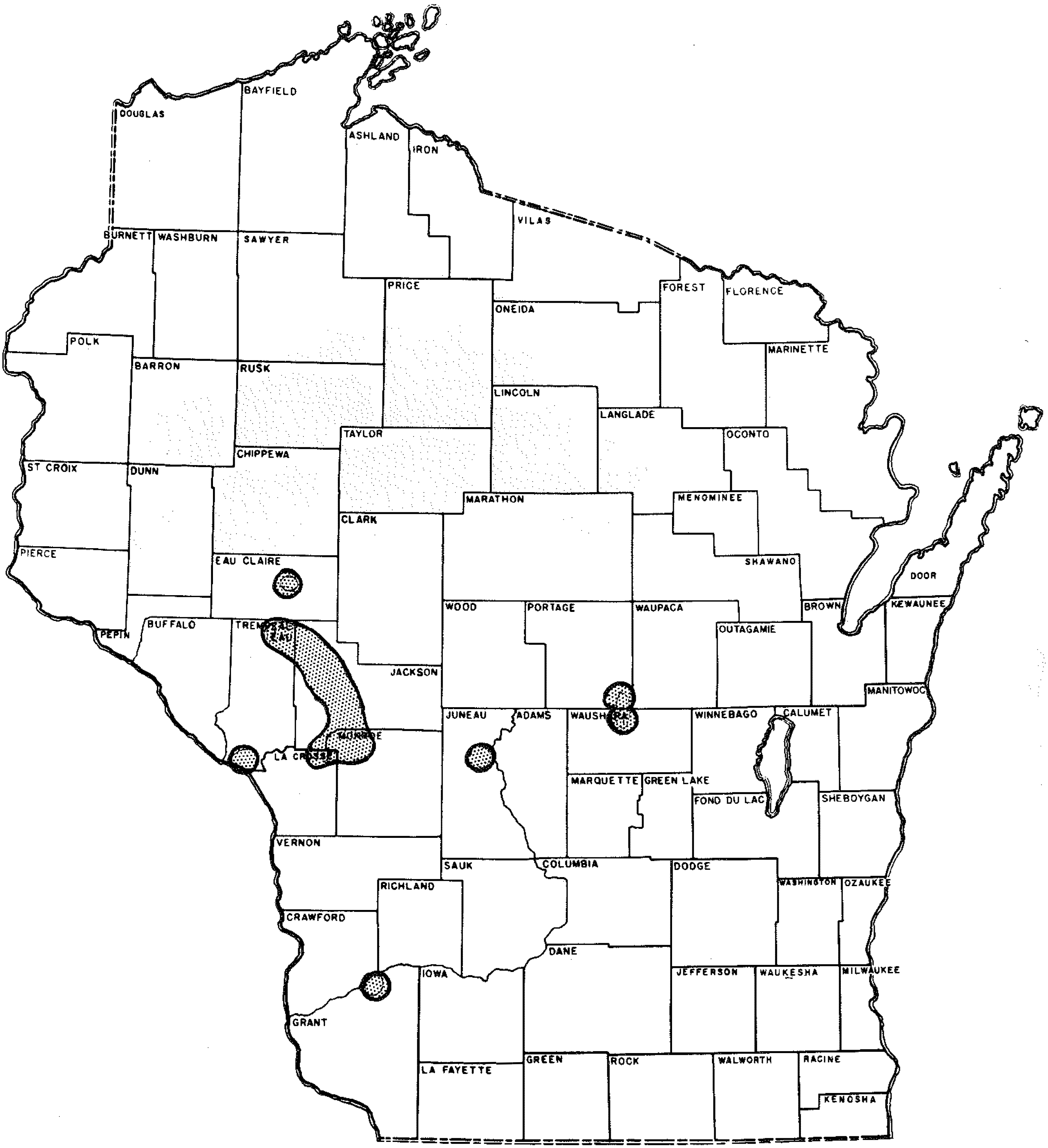

DOUGLAS
BAYFIELD
ASHLAND
IRON
VILAS
BURNETT
WASHBURN
SAWYER
PRICE
FOREST
FLORENCE
ONEIDA
POLK
MARINETTE
BARRON
RUSK
LINCOLN
LANGLADE
TAYLOR
OCONTO
CHIPPEWA
ST CROIX
DUNN
MARATHON
MENOMINEE
CLARK
PIERCE
EAU CLAIRE
SHAWANO
DOOR
WOOD
PORTAGE
WAUPACA
BROWN
KEWAUNEE
PEPIN
BUFFALO
TREMPEALEAU
OUTAGAMIE
JACKSON
MANITOWOC
JUNEAU
ADAMS
WAUSHARA
WINNEBAGO
CALUMET
MONROE
LA CROSSE
MARQUETTE
GREEN LAKE
FOND DU LAC
SHEBOYGAN
VERNON
SAUK
COLUMBIA
DODGE
WASHINGTON
OZAUKEE
RICHLAND
CRAWFORD
DANE
IOWA
JEFFERSON
WAUKESHA
MILWAUKEE
GRANT
LA FAYETTE
GREEN
ROCK
WALWORTH
RACINE
KENOSHA

Fig. 6 - Known location of brown spot needle blight (Lecanosticta acicola) infection on Scotch pine Christmas trees in 1968

The map on page 32 indicates the areas where the disease has been observed on Scotch pine Christmas trees.

Laboratory diagnosis has confirmed the disease in the following Scotch pine plantations in 1968.

| County | Location | Scotch Pine (Acres) | Severity (Defoliation) |
|---|---|---|---|
| Eau Claire | Sec. 9, T26N, R26W | 20 | Light |
| Grant | Sec. 18 & 19, T 8N, R 2W | 20 | Medium |
| Jackson | Sec. 33, T19N, R 5W | 100 | Light |
| | Sec. 28, T20N, R 3W | 40 | Light |
| | Sec. 7, T20N, R 3W | 20 | Heavy |
| | Sec. 5, T20N, R 3W | 30 | Medium |
| | Sec. 9, T20N, R 3W | 30 | Light |
| | Sec. 9, T20N, R 3W | 50 | Light |
| | Sec. 7 & 8, T21N, R 5W | 20 | Unknown |
| | Sec. 27 & 28, T22N, R 5W | 30 | Heavy |
| | Sec. 17 T22N, R 4W | 20 | Heavy |
| | Sec. 20 & 21, T23N, R 5W | 20 | Heavy |
| | Sec. 32, T24N, R 5W | 60 | Medium |
| | Sec. 25, T24N, R 6W | 80 | Heavy |
| | Sec. 29, T24N, R 5W | 20 | Medium |
| | Sec. 31, T19N, R 5W | 20 | Medium |
| Juneau | Sec. 2, T18N, R 3E | 20 | Light |
| | Sec. 23, T18N, R 3E | 20 | Light |
| LaCrosse | Sec. 4, T18N, R 5W | 60 | Light |
| | Sec. 9, T18N, R 5W | 1 | Light |
| Monroe | Sec. 28, T19N, R 3W | 80 | Light |
| | Sec. 25, T19N, R 4W | 30 | Light |
| | Sec. 4, T19N, R 4W | 20 | Light |
| Trempealeau | Sec. 9 & 16, T18N, R 9W | 40 | Medium |
| | Sec. 7, T24N, R 7W | 20 | Medium |
| | Total | 871 | |

Austrian Pine Needle Blight - Dothistroma pini Hulbray

This needle disease continues to damage Austrian pine Christmas trees but the limited acreage of Austrian pine plantations in Wisconsin doesn't make the disease a widespread economic problem. Many Austrian pine Christmas trees previously attacked by the fungus have been harvested or burned. It is interesting to note that often when Scotch pine and Austrian pine are grown together the Austrian pine will often be infected with Dothistroma pini while the Scotch pine remains healthy. Also in areas where Scotch pine is infected with brown spot (Lecanosticta acicola) the Austrian pine remains healthy. Occasional areas are found where Austrian pine is infected with Dothistroma pini and Scotch pine with Lecanosticta acicola and only with careful microscopic examination of the fruiting bodies can the two diseases be differentiated. Dothistroma pini has not been observed on red pine in Wisconsin.

### Ink Spot of Aspen - Ciborinia whetzelii (Seaver) Seaver

Ink spot foliage disease of aspen was common in the vicinity of Minong, Wisconsin (Washburn County). Dead leaves and ink spots were conspicuous but trees were not killed by the disease. See map on page 35.

### White Pine Needle Blight - Atmospheric Gases

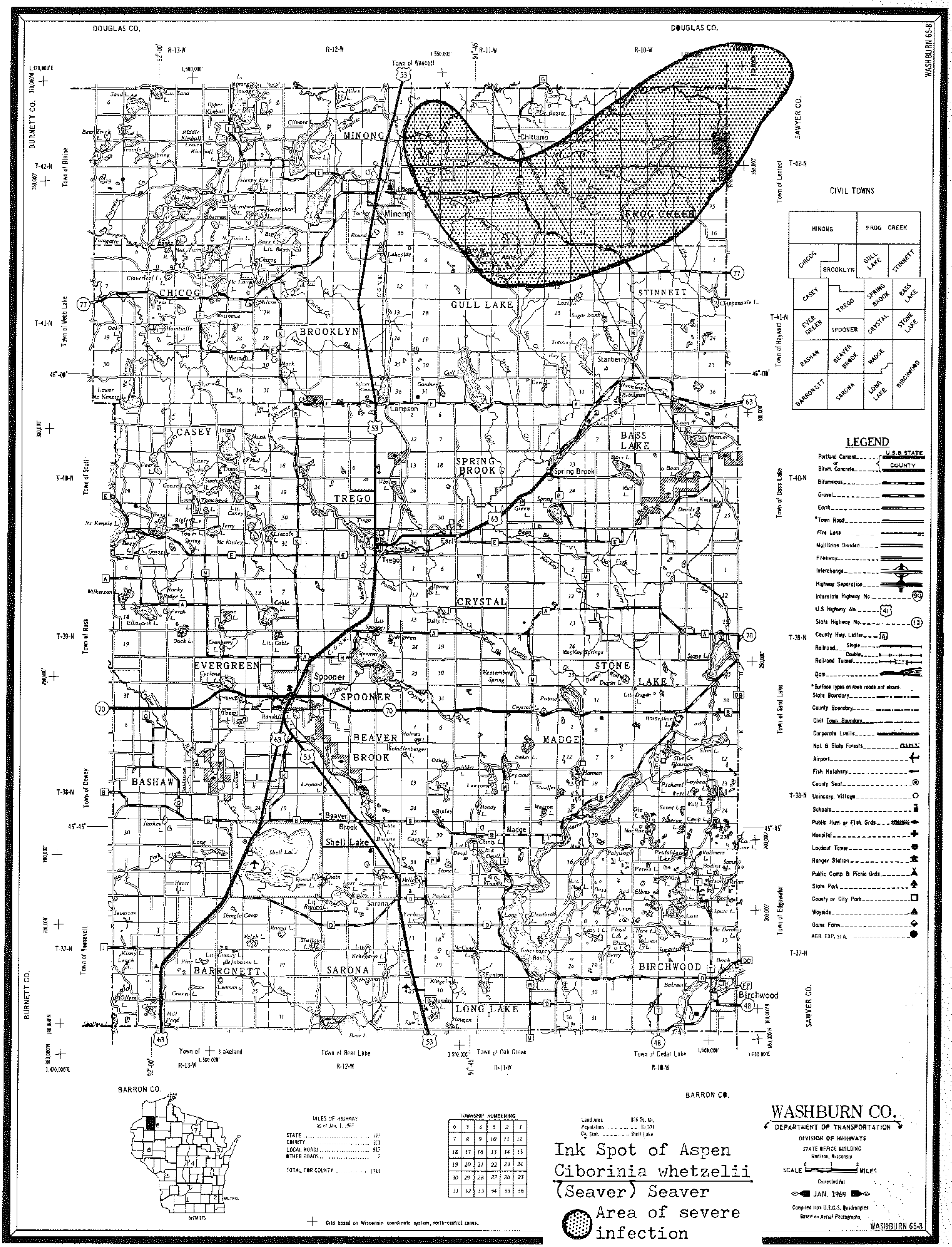
White pine needle blight, which is characterized by a reddish-brown discoloration of the needle tips, has been shown to be caused by atmospheric gases such as sulfur dioxide and ozone has been found in scattered areas throughout the state. A survey of white pine plantations in southern Wisconsin in 1967 revealed the disease was present in almost every plantation examined. Also a survey was conducted in the spring of 1967 to determine the cause of white pine needle blight. Polyethylene bags were placed over selected branches of needle-blighted trees and fastened so that atmospheric gases such as ozone would not come in contact with needles that developed that year. At the end of the 1967 growing season current year's needles within the bags were green while current year's needles outside the bags had typical needle blight symptoms.

A similar study was made in 1968 at three different sites in southern Wisconsin. Polyethylene bags were placed over selected branches of 10 needle-blighted trees and 10 check trees at each site. Trees were bagged on May 8, 1968 at the Albany Public Hunting Grounds in Green County (SW¼ SE¼, Section 16, T3N, R9E), on May 9, 1968 at the Wisconsin Dells School Forest in Adams County (SW¼ SE¼, Section 36, T14N, R6E) and at the Shapiro Plantation near Verona, Wisconsin in Dane County (SW¼ SW¼, Section 26, T6N, R7E). The current year's needles had not yet emerged at any of the sites.

Bagged white pines were examined periodically throughout the growing season. On previously needle-blighted trees the current year's needles that developed within polyethylene bags remained green while current year's needles outside the bags developed needle blight symptoms such as tipburn or fleck. The current year's needles on check trees remained green within and outside the polyethylene bags. Apparently the polyethylene bags excluded one or more atmospheric gases capable of inciting white pine needle blight.

Bel W-3 tobacco, which is susceptible to injury from atmospheric oxidants such as ozone, sulfur dioxide and oxides of nitrogen, was planted along with resistant Bel B tobacco in the Wisconsin Dells white pine plantation on June 27 and at the Albany and Verona plantations on June 28. At that time needle blight (tipburn) was already present on newly emerging white pine needles at all three sites. In fact, needle blight was observed prior to planting the tobacco on June 7 at the Albany site on emerging pine needles that were up to 3/4-inch long.

Weather fleck developed on Bel W-3 tobacco at all three sites and continued on new leaves until the October 18 observation date when frost-killed tobacco was noted at the Wisconsin Dells site. Weather fleck was not observed on Bel B tobacco at any of the sites.


DOUGLAS CO.
BURNETT CO.
SAWYER CO.
BARRON CO.
MINONG
FROG CREEK
CHICOG
BROOKLYN
GULL LAKE
STINNETT
CASEY
TREGO
SPRING BROOK
BASS LAKE
CRYSTAL
EVERGREEN
SPOONER
STONE LAKE
BEAVER BROOK
MADGE
BASHAW
BARRONETT
SARONA
LONG LAKE
BIRCHWOOD
Minong
Spooner
Shell Lake
Birchwood
CIVIL TOWNS
LEGEND
TOWNSHIP NUMBERING
MILES OF HIGHWAY as of Jan. 1, 1967
WASHBURN CO.
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
STATE OFFICE BUILDING
Madison, Wisconsin
SCALE MILES
Corrected for
JAN. 1969
Compiled from U.S.G.S. Quadrangles
Based on Aerial Photographs
WASHBURN 65-8

Ink Spot of Aspen
Ciborinia whetzelii
(Seaver) Seaver

▨ Area of severe infection

## Air Pollution

White pine at Devil's Lake State Park damaged in 1967 by fumes containing sulfuric acid from the adjacent ammunition plant was examined on July 19, 1968. At that time no tree mortality due to the acid mist was noted and 1968 needles were healthy. A Brinks Mist Eliminator was installed on the oleum plant stack at the Badger Army Ammunition Plant in June 1968 and has presumably eliminated discharge of sulfuric acid mist into the atmosphere. However, several white pine growing near the Badger Army Ammunition Plant fence were injured from herbicide applied to kill grass growing along the fence.

## NURSERY DISEASES

### Black Walnut Root Rot - Cylindrocarpon radicicola Wr.

Cylindrocarpon radicicola was found in association with root-rotted black walnut seedlings in unfumigated beds at Boscobel Nursery in the spring of 1968 while walnut seedlings grown in beds fumigated with Mylone 50D at 400 lbs./acre were healthy.

Sporodochia of C. radicicola were often present on the surface of infected roots and the major or initial rot was in the area where the nut was in contact with the root (Figure 7A). It is not known if C. radicicola is the primary pathogen involved but it is consistently associated with diseased roots. Isolation for known pathogens such as Cylindrocladium scoparium and Phytophthora cinnamomi were all negative.

## OTHER

### Winter Injury

Flagging red pine was observed in numerous plantations in Bayfield, Douglas, Marinette, Oneida and Vilas Counties this spring. The flagging branches occurred at random on trees less than 15 years old and resembled Saratoga spittlebug damage. However, spittlebug feeding scars were not always present. Several of the affected plantations were examined for Scleroderris pine canker the previous year (October, 1967) and no flagging or Scleroderris was observed at that time. In some of the areas flagging branches were colonized by Pityogenes beetles (see page 6).

Winter injury was also common and widespread on native and ornamental junipers in southern Wisconsin this spring.

### Hail Damage

A severe hail storm in Washburn County caused much damage to jack and red pine in T40N, R11W and T40N, R12W. Some plantings were completely ruined as potential Christmas trees.

### Needle Droop - (Rapid transpiration and limited water availability)

The rapid loss of moisture in early September caused this condition in small areas of several young red pine plantations in T45N, R10W; T45N, R11W and T46N, R10W, Douglas County.

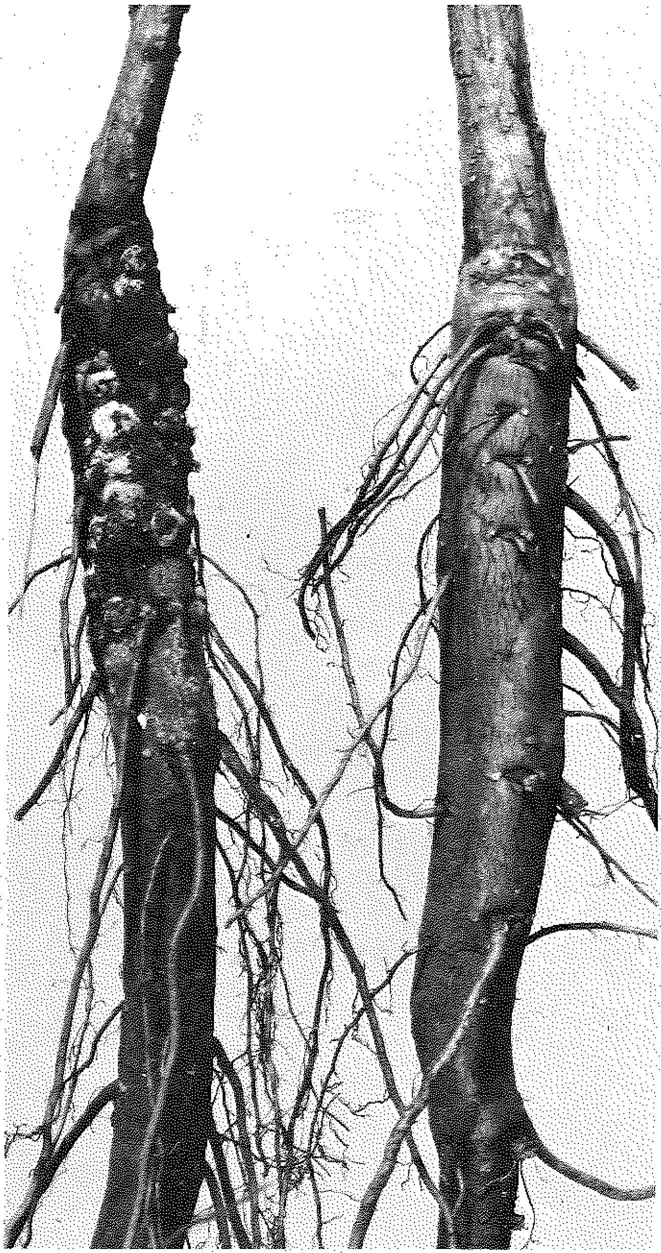


Fig. 7A - Surface view of 1-0 black walnut seedlings from Boscobel Nursery. Diseased seedling on the left and healthy seedling on the right. Note the sporodochia of Cylindrocarpon radicicola on the surface of the diseased seedling.

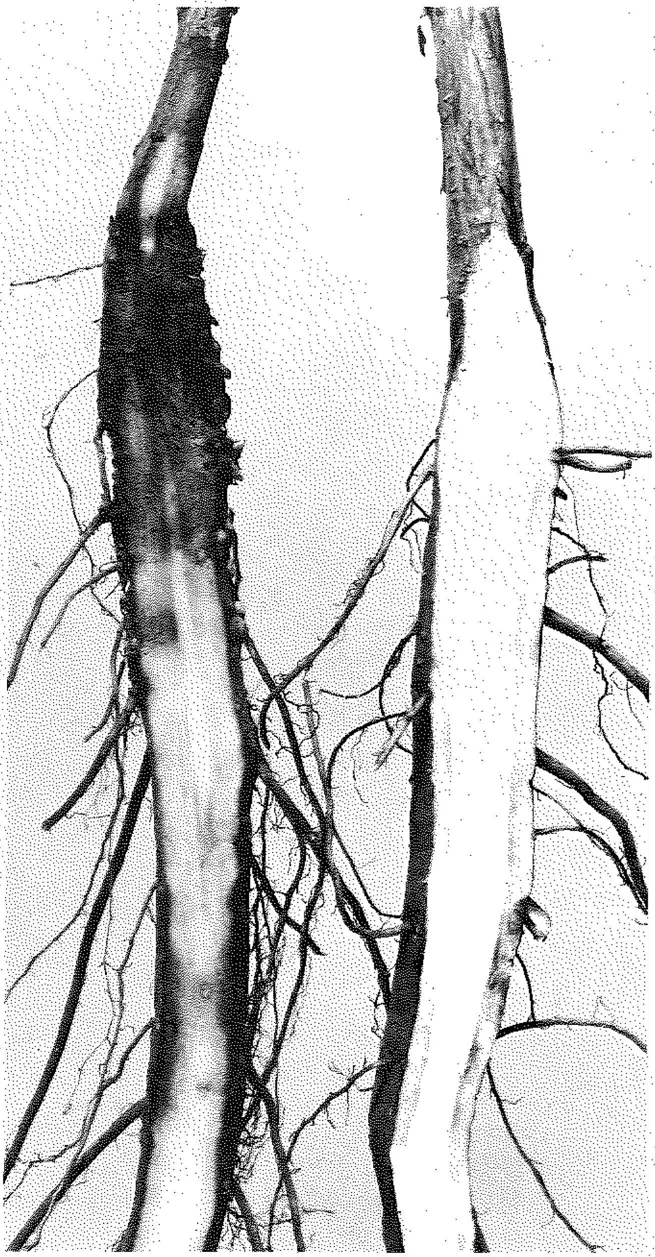


Fig. 7B - Longitudinal section of the same diseased and healthy seedlings.

# THE NATIVE ELM BARK BEETLE IN WISCONSIN - 1968

by
Ray Weber
Technical Assistant
Forest Pest Control Section
Department of Natural Resources
Antigo, Wisconsin

November 1968

## Introduction

The recent spread of Dutch elm disease into the commercial forest type of northern Wisconsin, creates a new problem for some forest managers. The situation is of greatest concern in Menominee County, which contains approximately 116 million board feet of merchantable elm. The disease was first reported in the county during 1967. However, it probably has been present for several years. The apparent rapid spread and intensification during 1968 - mostly along watercourses - is not unique to Menominee County. A similar northward spread is eivdent throughout Marathon, Shawano, Marinette and Oconto Counties. Positive cases have also been found by the writer in all northeastern Wisconsin counties up to the Michigan border.

The principal vector of Dutch elm disease in northern Wisconsin is presumed to be the native elm bark beetle, *Hylurgopinus rufipes* (Eichh.). The smaller European bark beetle, *Scolytus multistriatus* (Marsh.), apparently is not present in this area. The occurrence, distribution and habits of the native elm bark beetle in northern Wisconsin are not well known. The writer was therefore employed on a part time basis during the period May 15th to November 15, 1968 in an effort to increase our knowledge of this species.

An extensive survey revealed that *H. rufipes* is an abundant species in the northeast area wherever suitable elm material is available for brood purposes. Collections were made in all counties except Vilas, where elm is a very scarce tree. Sampling indicated the population to be less abundant northward. Detailed observations on the life history and habits were concentrated in Menominee County and adjacent portions of Langlade County. Although the period of observation was not long enough to obtain a complete picture, the tentative information obtained may be of value.

## Methods and Materials

Several devices were tried in an effort to determine adult emergence periods from elm brood material.

1. Screen traps around infested standing trees
2. Infested material placed in screen cages and cans
3. Tanglefoot boards (about 12x12 inches) placed on living elms adjacent to brood material.

None of these proved to be of much value except the tanglefoot boards. Collections from these indicated a minor emergence period from brood material during June and the major emergence period from mid-August to early October.

The best information on seasonal history and habits was obtained by periodic sampling of the same brood material. Brood material is dead or dying elm which becomes attractive for egg laying purposes as long as the bark remains tough and moist. This may be either in the form of logging slash or standing dead and dying elms. The former was by far the best for sampling purposes as the date that the brood material died is definitely known. Study material included trap logs, tops from a known logging date and trees cut to obtain samples for diagnosis of Dutch elm disease. In standing trees, where the material becomes progressively suitable for brood purposes, both the over-wintering adult and over-wintering larvae generations may be present. This situation greatly complicates the study of seasonal history.

During August 1968, several American elms were treated with Silvisar, a chemical silvicide produced by the Ansul Chemical Company. Treatment was applied in an effort to determine if such killed trees would be rendered undesirable as brood material for the elm bark beetle. Trees ranged in size from 8" to 15" DBH. Silvisar was applied in a series of axe cuts around the base of the trunk. Cuts extended into the xylem. Nearby elms of comparable size were used as controls by completely girdling the bole. Examination following chemical treatment indicated that foliage began to die within a week. Complete kill generally occurred within three weeks. Top kill on controls took place much slower and a complete mortality did not occur until the end of the growing season. By the end of October there was no evidence of beetle invasion in either the treated trees or controls. An examination next spring during the beetle brood season may determine whether or not the August Silvisar treatment is an effective repellent.

## Seasonal History and Habits

As reported by other observers, there appears to be two separate generations or broods; one that over-winters as adults (spring brood) and one that over-winters as larvae (summer brood). The over-wintering adults constituted by far the major part of the population during the observation period. Brood galleries were found in all parts of the trees, including dead limbs up to 100 feet above the ground. None were found in limbs less than 3 inches in diameter. Egg galleries were generally confined to the shady side of the trunk or limb. They were less prevalent in material directly on the ground. Ovipositing in an individual gallery extended over a period of two to three weeks. Larval mines at the entry end were up to 3/4 inch long before a complete hatch of eggs occurred at the distal end. Dead mature adults were frequently found at the end of the brood gallery.

Seasonal development of the spring brood may be summarized as follows:

| Stage | Period |
|---|---|
| Eggs present | May 15 - Aug. 15 |
| Larvae present | June 10 - Nov. 15+ |
| Pupae present | July 14 - Nov. 15+ |
| Young adults present | Aug. 17 - Nov. 15+ |

Brood material used was primarily dormant season (November to April) logging slash. By the time adult emergence began in mid-August, the bark was loose, dry and crumbly. It is unlikely that this condition is attractive for further egg laying by either the new adults or mature adults from the summer brood. There was also no evidence that slash from logging during the July to October period was utilized as brood material. Such material can be checked next spring to see whether or not it is utilized. It appears that no more than one generation is produced by the spring brood. In fact, at the time of final inspection in mid-November, there were still a few retarded larvae, pupae and callow adults in the brood material where egg laying was begun in mid-May. It is unlikely that these will survive over-winter, but a spring examination may determine the fact. Examination of nearby living elms during September and October revealed the presence of over-wintering adults feeding in hibernation tunnels in the bark.

Seasonal development of the summer brood (from over-wintering larvae) can be summarized as follows:

In June 1967 Slash

| Stage | Period |
|---|---|
| Pupae | June 1 - 25 |
| Adults | June 12 - July 10 |

To June 1968 Slash

| Stage | Period |
|---|---|
| Eggs | Aug. 2 - Sept. 5 |
| Larvae | Aug. 27 - Winter |
| Pupae | Oct. 1 - Winter |
| New Adults | Oct. 10 - Winter |

This brood apparently forms only a minor part of the population. At least this was the case in 1968. Egg laying was confined only to June 1968 slash and freshly cut trap logs placed in June. It is also apparent that a full and partial generation is produced. At the time of final inspection in mid-November, there were variousstages of larval development but only a few pupae and callow adults. An inspection in early spring 1969 should determine whether or not the pupae and callow adults can survive winter conditions in the brood material.

## Discussion

It is a generally accepted fact that in order to transmit the disease from infected to healthy trees, the adult beetle must score the xylem with its feeding tunnels. Most of this activity occurs in the spring before the summer wood is formed. It is during this period of spring wood formation that nearly all infections are reported to occur. With a high population of over-wintering adults and abundant brood material present, there is certainly ample opportunity for *H. rufipes* to transmit the disease.

The reason for the spread and infensification of Dutch elm disease along waterways, roads and open areas is not definitely known. However, it is probably due to a combination of several factors:

1. The occurrence of elm as the most abundant species in swamp hardwood types. Thus, more accessible feeding area is available for the insect vector. Intensification of the disease is also possible through root grafts.

2. The higher incidence of dead and dying elms from other causes provides a continual abundance of brood material.

3. The open nature of the elm type provides relatively unobstructed flyways for the beetle, to transmit the disease through its feeding habits.

4. The relatively low crowns, compared to elms in a mixed northern hardwood type. Thus, more accessible feeding area is available for possible infection.

The adult beetle is seldom able to penetrate to the xylem of thick-barked trees during the spring feeding period. This fact may explain why sawlog trees with a high crown may not become infected as readily as smaller or low-crowned trees. Large trees with a low crown, however, could be readily infected by beetle feeding in the lower branches. Disease symptoms are usually characterized by the sudden wilting of the entire trees, or a large part, rather than branch flagging. This would be an indication of trunk or large branch inoculation.

The severe buildup of the disease in Menominee County during 1968 has occurred along the Wolf River and its tributaries. This is indicated on the attached county map. The only exception is the northwest part of the county (largely in T30N, R13 and 14 east) where no positive cases have been found. Only a few infected trees have been located thus far in the mixed northern hardwood type. These are practically all along roads, in town, or along field edges. These isolated infections have been point-marked with a white "x", and are also indicated on the county map. Spread of the disease from these locations into adjacent northern hardwood types can be readily followed in the future.

## Future Work Plans

The following recommendations are suggested for continuing the study of the native elm bark beetle and the spread of Dutch elm disease in Menominee County:

1. Continue to check for disease symptoms in the northern hardwood types, particularly in sawlog trees, in the vicinity of the isolated cases point-marked in 1968.

2. Examine the Silvisar treated trees and controls next spring to determine whether or not they are used for brood purposes; also treat some additional trees in the spring.

3. Make spring examinations of slash from logging during the period July-September to determine whether or not this material is used for brood purposes in 1969.

4. Examine the 1968 brood material early next spring to determine which life stages of both broods are able to withstand winter conditions.

The latest recommendations for elm management in Menominee County, dated September 23, 1968 are contained in the attached memorandum from the Forest Pest Control Section, Department of Natural Resources.

DEPARTMENT OF NATURAL RESOURCES

Southern Area Headquarters
Route 2
Madison 53711

September 23, 1968

An intensive field study of the Dutch elm disease situation in Menominee County during the past year has pointed out the need for some modifications of the recommendations of March 20, 1967. The following revised recommendations based on current information are suggested to cope with the disease:

I. Dense concentrations of elms will be mapped and observed closely for initial infection through recurrent systematic aerial and ground surveys by the Department of Natural Resources Area Entomologist. Menominee Enterprises can provide information on the composition of elm from tally records.

II. Basal area levels may be reduced to the lower limits of the recommended levels in the sawtimber portion of the stand. (Trees over 11" DBH)

III. Strive for crown separation between adjacent elms to reduce possibility of disease spread through root grafts.

IV. Harvest elms 24" DBH and larger regardless of risk and vigor. Other species of medium risk and vigor will be retained in the residual stand to maintain minimum basal area levels.

V. Harvest elms under 24" DBH when criteria for marking favor equally the harvesting of an elm or another species.

VI. Salvage operations should be programmed for heavily infected areas where feasible. The forester for Menominee Enterprises Inc. and the Department of Natural Resources forester will jointly select areas for salvage.

VII. Slash shall be treated as recommended by the Area Entomologist.

VIII. All elm logs hauled to the mill should be piled in one location to facilitate their inspection and rapid disposal.

## NUISANCE PESTS

The Department supported a research project on mosquitoes which started in 1966 and was completed this year. Personnel at Point Beach State Forest, Wyalusing, Interstate, and Tower Hill State Parks cooperated in obtaining data on biting counts and operated light traps.

Investigated were breeding sites, use of larvicides, and relationships between mosquitoes found in breeding areas and those collected in light traps and in biting catches.

The study was made by a graduate student, Mr. Charles Porter, under the guidance of Dr. Walter Gojmerac of the Department of Entomology, University of Wisconsin.

In addition to the thesis which is being completed, information obtained provides the basis for mosquito control at Point Beach State Forest, where the most intensive study was made, and will apply to mosquito control situations in other state recreation areas.

Conclusions reached were:

1. Pools in the state forest are prolific producers of nuisance as well as non-nuisance mosquitoes.
2. Light traps are of little or no value in predicting or diagnosing mosquito problems at Point Beach State Forest.
3. Draining or filling some breeding pools should be considered.
4. BROMOPHOS at 0.1 pound per acre and ABATE at 0.03 pound per acre are about equally effective insecticides against larval stages of mosquitoes. Single treatments with these insecticides do not appear to harm other organisms significantly.
5. Temporary relief from troublesome adult mosquitoes can be obtained by fogging with malathion or naled (Dibrom).
6. Each recreation area and its mosquito problems must be treated as individual units. Mosquito species differ and thus control procedures will vary.

# CHEMICAL CONTROL

## JACK-PINE BUDWORM

Three chemicals were field-tested in the Northwest Area against the budworm in 1968 in the continuing search for a replacement for DDT. The aerial applications were a joint effort by the Department, University of Wisconsin, and suppliers of the test insecticides. They were made in southern Douglas County on June 28 and 29 during a very brief period of favorable weather against a dwindling larval population.

## SELECTION OF TEST AREAS

Early-instar larval counts were made to determine adequacy of populations in blocks of timber which had tentatively been selected on the basis of similarity in age, stocking, and other characteristics and homogeneity of budworm populations. Counts of 20 second and third instar larvae per 30 jack pine shoots and flowers were considered sufficient to provide a suitable insect population for the tests. Jack pine stands with adequate budworm populations were numerous in Douglas County, but slow and erratic development of larvae and appearance of parasites in some localities made selection of blocks difficult.

Retarded larval development in the Towns of Gordon and Highland necessitated last-minute changes in test sites, and all were finally located west of Wascott, a few miles to the southwest, where insect development was progressing at a more uniform rate.

## EVALUATION PROCEDURES

Courses along which population evaluation counts were to be made were marked in the test and check blocks on June 25 and 26. The courses were laid-out in a "V"-shaped pattern so they covered the treatment blocks and crossed the spray swaths twice in each block. Pre-spray larval counts on all blocks were completed on June 28. Larval counts were made on two replications of ten plots within each test block and check block. Ten twigs, each with 15 inches of needle-bearing surface, were clipped from at least five different trees at each plot, and the budworm larvae and pupae on each twig were counted and recorded. Two check blocks were located a safe distance from areas to be treated to avoid contamination by the chemicals.

Post-spray larval counts were completed in the same manner along the same courses 72 hours after treatment.

## RESULTS

Matacil was applied the morning of June 29. Dylox and Gardona were applied during the evening of the same day. Results of the test applications are summarized below, and details concerning the chemicals, application equipment, atmospheric conditions, calculations, and other pertinent information are provided on the operational data pages and others that follow.

| Test Site Legal Description | Insecticide | Rate of Application/Acre | % Chemical Control |
|---|---|---|---|
| S160A Sec. 29 T43N R13W | Matacil | 0.15 lb./14 fl. oz. | 42.2% |
| W160A Sec. 6 T42N R13W | Dylox | 0.5 lb./16 fl. oz. | 18.1% |
| N½NW¼ Sec. 3 T42N R13W | Gardona | 0.5 lb./gal. (128 fl. oz.) | 16.3% |
| S½SE¼ Sec. 3 T42N R13W | Gardona | 1.0 lb./gal. (128 fl. oz.) | 21.6% |

Following are operational data sheets for test applications of insecticides for control of jack-pine budworm larvae. Aerial applications of the chemicals were made on isolated blocks of timber near the Douglas-Washburn County boundary.

All pre-spray counts were made on the same day in blocks scheduled for treatment and those to be used as checks.

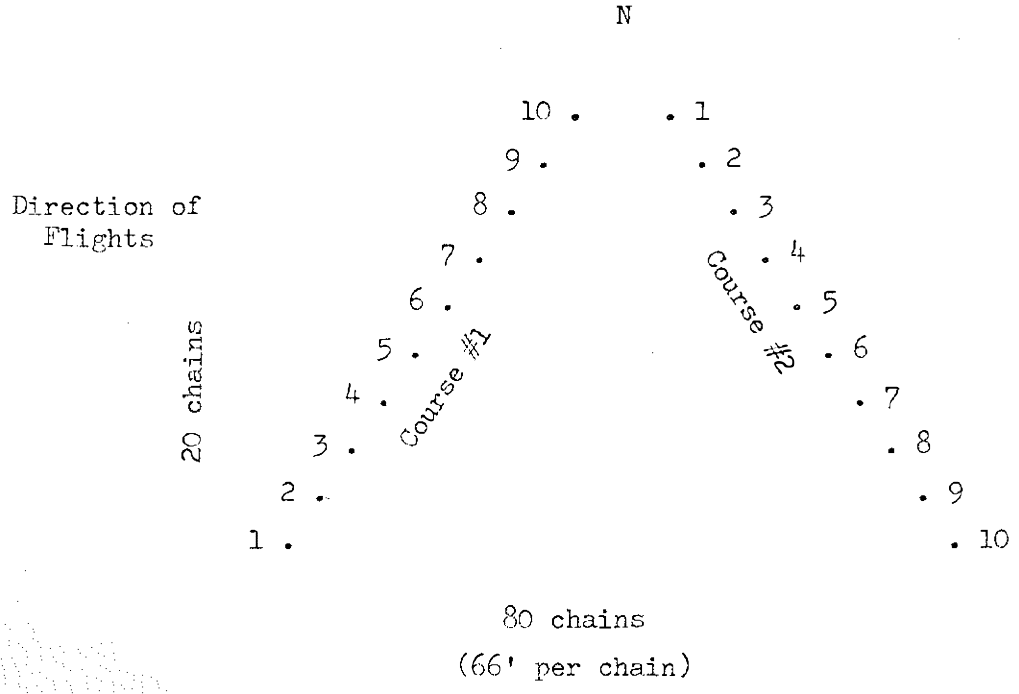
Two untreated blocks were used as checks. One located in Section 33, T43N R13W was used in evaluating control attained with Matacil because post-spray counts were made in both the check and treated blocks the same day, July 2.

For the same reason the treatments with Dylox and Gardona were evaluated using data from an untreated check block in Section 35 of T43N R13W. Post treatment counts were made on these blocks on July 3.

Computations - Jack Pine Budworm Control

Counts for each check and treatment block are shown in the following table. Each figure represents the total number of larvae on 100 twigs collected at 10 stations along each of 2 courses diagonally across the flight lines.

Schematic Layout of Spray Block
With Sampling Points


N
Direction of Flights
20 chains
Course #1
Course #2
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
80 chains
(66' per chain)

All pre-spray counts were made on June 28. All post-spray counts were made on July 3 except those for Matacil and the check block in Section 33 which were made on July 2.

## Pre- and Post-Spray Larval Counts
## Jack Pine Budworm Control

| Chemical | Course No. | Pre-Spray (Insects/100 Twigs) | Post-Spray (Insects/100 Twigs) |
|---|---|---|---|
| Dylox | 1 | 310 | 159 |
| | 2 | 219 | 154 |
| | | Avg. 264.5 | Avg. 156.5 |
| Gardona (0.5#) | 1 | 255 | 162 |
| | 2 | 172 | 96 |
| | | Avg. 213.5 | Avg. 129 |
| Gardona (1#) | 1 | 173 | 99 |
| | 2 | 173 | 97 |
| | | Avg. 173 | Avg. 98 |
| Matacil | 1 | 455 | 214 |
| | 2 | 232 | 119 |
| | | Avg. 343.5 | Avg. 166.5 |
| Check (Sec. 33) | 1 | 312 | 254 |
| | 2 | 250 | 219 |
| | | Avg. 281 | Avg. 236.5 |
| Check (Sec. 35) | 1 | 297 | 226 |
| | 2 | 268 | 182 |
| | | Avg. 282.5 | Avg. 204 |

Population reductions were computed with Abbott's formula*:

$$Po = 1 - \frac{Cb \times Ta \times 100}{Ca \times Tb}$$

where Po = population reduction %
Cb = pre-spray count, check area
Ta = post-spray count, treated area
Ca = post-spray count, check area
Tb = pre-spray count, treated area

*Abbott, W. A. J.E.E. Vol. 18, No. 65, 1925.

Counts used in the computations were averages of two courses in each block. Pooling the figures for two courses provided essentially the same answers.

Dylox

$$Po = 1 - \frac{(282.5 \times 156.5)}{(204 \times 264.5} \times 100$$

$$= 1 - \frac{44211.25}{53958} \times 100$$

$$\begin{array}{r} = 1.000 \\ - \underline{.819} \\ .181 \end{array} \times 100 = 18.1\%$$

Po = 18.1%

Matacil

$$Po = 1 - \frac{(281 \times 166.5)}{(236.5 \times 343.5)} \times 100$$

$$= 1 - \frac{(467865)}{(81237.75)} \times 100$$

$$\begin{array}{r} = 1.000 \\ - \underline{.578} \\ .422 \end{array} \times 100$$

Po = 42.2%

Gardona (0.5#/A)

$$Po = 1 - \frac{(282.5 \times 129}{(204 \times 213.5)} \times 100$$

$$= 1 - \frac{36442.5}{43554} \times 100$$

$$\begin{array}{r} = 1.000 \\ - \underline{.837} \\ .163 \end{array} \times 100$$

Po = 16.3%

Gardona (1#/A)

$$Po = 1 - \frac{(282.5 \times 98)}{(204 \times 173)} \times 100$$

$$= 1 - \frac{27685}{35292} \times 100$$

$$\begin{array}{r} = 1.000 \\ - \underline{.784} \\ .216 \end{array} \times 100$$

Po = 21.6%

## DOUGLAS - WASHBURN COUNTY OPERATIONAL DATA - Gardona

TARGET INSECT: Jack-Pine Budworm - *Choristoneura pinus* Freeman
CHEMICAL NAME: 2-chloro-1-(2, 4, 5-trichlorophenyl vinyl dimethyl phosphate
PRODUCER: Shell Chemical Company AMOUNT ACTIVE INGREDIENT: 4#/gal.
FORMULA NO.: 3-KCJ-503
SIZE OF CONTAINERS: 5 gal. TOTAL ON HAND: 6 TOTAL NO. USED: 2 (10 gal.)
PROPOSED RATE OF APPLICATION: 0.5#/gal./A.
ACTUAL RATE OF APPLICATION: 0.5#/gal/A.
CALIBRATION MATERIAL: #2 Fuel Oil
SIZE OF SPRAY BLOCK TO BE TREATED: 80 Acres
ACREAGE ACTUALLY TREATED: 80 Acres
AMOUNT OF CHEMICAL LOADED: 81.5 gal. (Spray System filled with 1.5 of gallons loaded)
AMOUNT OF CHEMICAL APPLIED: 80 gal.
AMOUNT OF CHEMICAL LEFT IN SYSTEM AFTER SPRAYING: 1.5 gal.
DISPOSAL OF EXCESS: Left in spray system
AIRPLANE: Piper Pawnee 150
SPRAY TANK: Fiberglass USEFUL TANK CAPACITY: 80 gal.
PUMP: Wind-driven, Simplex, Size 1, Type cc.
TYPE CHECK VALVE: Spraying Systems #4666
STRAINERS: 100 mesh, stainless steel
SPRAY TIP DESIGNATION: Spraying Systems #8010 NUMBER OF SPRAY TIPS USED: 12
POSITIONS OF NOZZLE LOCATIONS USED INDICATED BY UNDERLINED NUMBERS BELOW:

| LEFT WING: | | RIGHT WING: |
|---|---|---|
| 11-10-9-8-7-6-5-4-3-2-1 | FUSELAGE | 1-2-3-4-5-6-7-8-9-10-11 |

FLOW RATE: 12 gpm Theoretical = Actual
EFFECTIVE SWATH WIDTH: 66'
PRESSURE IN SYSTEM DURING SPRAYING: 40# STEADY: Yes X No ______
AIRSPEED: 90 mph = groundspeed AIRPORT LOCATION: Solon Springs, Douglas Co.
LEGAL DESCRIPTION OF TREATED BLOCKS: N½ NW¼ Sec. 3, T42N, R13W
DATE OF APPLICATION: June 29, 1968
TIME OF SPRAY APPLICATION: START: 7:48 p.m. CDST FINISH: 8:20 p.m. CDST
NUMBER OF SWATHS FLOWN: 20 LENGTH: .5 mi.
NUMBER OF 66 FOOT CHAINS PER SWATH: 40 TOTAL CHAINS FLOWN: 800
DIRECTION OF FLIGHT:
HEIGHT ABOVE CANOPY: 50'
WIND OR AIR MOVEMENT AT TIME OF SPRAYING: Calm to slight drift from East
TEMPERATURE: 23° C (73.4° F)
PRECIPITATION: None. Sky clear. Rain to south of block about 2:00 a.m.
OTHER NOTES: 10 gal. 4#/gal. Gardona mixed with 70 gal. #2 fuel oil.

## DOUGLAS - WASHBURN COUNTY OPERATIONAL DATA - Gardona

TARGET INSECT: Jack-Pine Budworm - Choristoneura pinus Freeman
CHEMICAL NAME: 2-chloro-1- (2, 4, 5-trichlorophenyl vinyl dimethyl phosphate
PRODUCER: Shell Chemical Company AMOUNT ACTIVE INGREDIENT: 4#/gal.
FORMULA NO.: 3-KCJ-503
SIZE OF CONTAINERS: 5 gal. TOTAL ON HAND: 6 (30 gal.)
TOTAL NO. USED: 4 (20 gal.)
PROPOSED RATE OF APPLICATION: 1#/gal./A. ACTUAL RATE OF APPLICATION: 1#/gal./A.
CALIBRATION MATERIAL: #2 Fuel Oil
SIZE OF SPRAY BLOCK TO BE TREATED: 80 Acres
ACREAGE ACTUALLY TREATED: 80 Acres
AMOUNT OF CHEMICAL LOADED: 80 gal. (Spraying system full to 1.5 gal. capacity)
AMOUNT OF CHEMICAL APPLIED: 80 gal.
AMOUNT OF CHEMICAL LEFT IN SYSTEM AFTER SPRAYING: 1.5 gal.
DISPOSAL OF EXCESS: Buried
AIRPLANE: Piper Pawnee 150
SPRAY TANK: Stainless Steel USEFUL TANK CAPACITY: 20 gal.
PUMP: Wind-driven, Simplex, Size 1, Type cc.
TYPE CHECK VALVE: Spraying Systems #4666
STRAINERS: 100 mesh, stainless steel
SPRAY TIP DESIGNATION: Spraying Systems #8010 NUMBER OF SPRAY TIPS USED: 12
POSITION OF NOZZLE LOCATIONS USED INDICATED BY UNDERLINED NUMBERS BELOW:

| LEFT WING: | | RIGHT WING: |
|---|---|---|
| 11-10-9-8-7-6-5-4-3-2-1 | FUSELAGE | 1-2-3-4-5-6-7-8-9-10-11 |

FLOW RATE: 12 gal./min. (12 tips x 1 gpm)
EFFECTIVE SWATH WIDTH: 66 ft.
PRESSURE IN SYSTEM DURING SPRAYING: 40# STEADY: Yes X No
AIRSPEED: 90 mph = Groundspeed AIRPORT LOCATION: Solon Springs, Douglas Co.
LEGAL DESCRIPTION OF TREATED BLOCKS: SE¼ Sec. 3, T42N, R13W
DATE OF APPLICATION: June 29, 1968
TIME OF SPRAY APPLICATION: START: 8:55 p.m. CDST FINISH: 9:15 p.m. CDST
NUMBER OF SWATHS FLOWN: 21.5 @ 0.5 mi. each LENGTH: .5 mi. each
NUMBER OF 66 FOOT CHAINS PER SWATH: 40 + 2 TOTAL CHAINS FLOWN: 800 sprayed
DIRECTION OF FLIGHT: E-W starting at South end
HEIGHT ABOVE CANOPY: 50'
WIND OR AIR MOVEMENT AT TIME OF SPRAYING: Steady from E NE up to 3 mph
TEMPERATURE: 18° C = 64.4° F
PRECIPITATION: Heavy rain to south of block about 2 a.m.
OTHER NOTES: Darkness became a handicap. While 21.5 swaths were counted as sprayed, cut-offs and cut-ins were less precise, but equipment set up for 1 g.p.a. delivery has consistently produced that rate of output.

20 gal. concentrate mixed with 60 gal. #2 fuel oil.

## DOUGLAS - WASHBURN COUNTY OPERATIONAL DATA - Dylox ULV

TARGET INSECT: Jack-Pine Budworm - Choristoneura pinus Freeman
CHEMICAL NAME: Dimethyl (2,2,2-trichloro-1-hydroxyethyl) phosphonate
PRODUCER: Chemagro Corp. BATCH NO.: 8059561 and 8059510
AMOUNT ACTIVE INGREDIENT: 4#/gal. FORMULA NO.: 1051
SIZE OF CONTAINERS: 5 gal. each TOTAL ON HAND: 6 cans
PROPOSED RATE OF APPLICATION: 1/2# in 16 fl. oz./A.
ACTUAL RATE OF APPLICATION: 15.52 fl. oz./A.
CALIBRATION MATERIAL: Dylox
SIZE OF SPRAY BLOCK TO BE TREATED: 160 Acres
ACREAGE ACTUALLY TREATED: 164 Acres
AMOUNT OF CHEMICAL LOADED: 21.5 gal.
AMOUNT OF CHEMICAL APPLIED: 19.875 gal.
AMOUNT OF CHEMICAL LEFT IN SYSTEM AFTER SPRAYING: 1.625 gal.
DISPOSAL OF EXCESS: Buried
AIRPLANE: Piper Pawnee 150
SPRAY TANK: Stainless Steel USEFUL TANK CAPACITY: 20 gal.
PUMP: Wind-driven, Simplex, Size 1, Type cc.
TYPE CHECK VALVE: Spraying Systems
STRAINERS: 100 mesh, stainless steel
SPRAY TIP DESIGNATION: Spraying Systems #80015 NUMBER OF SPRAY TIPS USED: 11
POSITION OF NOZZLE LOCATIONS USED INDICATED BY UNDERLINED NUMBERS BELOW:

LEFT WING: RIGHT WING:

11-10-9-8-7-6-5-4-3-2-1 FUSELAGE 1-2-3-4-5-6-7-8-9-10-11

FLOW RATE:
(Proposed - 1.5 gal./min.
(Theoretical - 1.65 gal./min. (11 tips x .15 gpm/tip
(Actual - 1.46 gal./min.

EFFECTIVE SWATH WIDTH: 66'
PRESSURE IN SYSTEM DURING SPRAYING: 40# STEADY: Yes X No
AIRSPEED: 90 mph = Groundspeed AIRPORT LOCATION: Solon Springs, Douglas Co.
LEGAL DESCRIPTION OF TREATED BLOCKS: W side Sec. 6, T42N, R13W
DATE OF APPLICATION: June 29, 1968
TIME OF SPRAY APPLICATION: START: 6:19 p.m. CDST FINISH: 6:47 p.m. CDST
NUMBER OF SWATHS FLOWN: 20.5 @ 1 mile each UNIFORM LENGTH: Yes X No
NUMBER OF 66 FOOT CHAINS PER SWATH: 80 TOTAL CHAINS FLOWN: 1,640
DIRECTION OF FLIGHT: E-W, started South end of block
HEIGHT ABOVE CANOPY: 50'
WIND OR AIR MOVEMENT AT TIME OF SPRAYING: Slight from N NW, less than 3 mph with gusts to 5 mph
TEMPERATURE: 25° C = 77° F
PRECIPITATION: None
OTHER NOTES: Spraying conditions good

## DOUGLAS - WASHBURN COUNTY OPERATIONAL DATA - Matacil ULV

TARGET INSECT: Jack-Pine Budworm - Choristoneura pinus Freeman
CHEMICAL NAME: 4 Dimethylamino-m-tolyl methyl carbamate
PRODUCER: Chemagro Corp. BATCH NO.: 8059057
AMOUNT ACTIVE INGREDIENT: 2.8#/gal. FORMULA NO.: 1340
SIZE OF CONTAINERS: 5 gal. TOTAL ON HAND: 5 TOTAL NO. USED: 4 + 1 partial
PROPOSED RATE OF APPLICATION: 2.4 oz. active in 13.7 fl. oz./A.
ACTUAL RATE OF APPLICATION: 2.446 oz. active in 13.978 fl. oz./A.
CALIBRATION MATERIAL: Panasol AN-2, Control No. 8059-585
SIZE OF SPRAY BLOCK TO BE TREATED: 160 Acres
ACREAGE ACTUALLY TREATED: 182 Acres
AMOUNT OF CHEMICAL LOADED: 20 gal. + 1.5 gal. to charge spray system
AMOUNT OF CHEMICAL APPLIED: 19.875 gal.
AMOUNT OF CHEMICAL LEFT IN SYSTEM AFTER SPRAYING: 1.625 gal. (6.5 qts.)
DISPOSAL OF EXCESS: Buried
AIRPLANE: Piper Pawnee 150
SPRAY TANK: Stainless Steel USEFUL TANK CAPACITY: 20 gal.
PUMP: Wind-driven, Simplex, Size 1, Type cc.
TYPE CHECK VALVE: Spraying Systems #4666
STRAINERS: 100 mesh, stainless steel
SPRAY TIP DESIGNATION: Spraying Systems #8001 NUMBER OF SPRAY TIPS USED: 14
POSITION OF NOZZLE LOCATIONS USED INDICATED BY UNDERLINED NUMBERS BELOW:

| LEFT WING: | | RIGHT WING: |
|---|---|---|
| $\underline{11}-\underline{10}-9-\underline{8}-7-\underline{6}-5-\underline{4}-3-\underline{2}-\underline{1}$ | FUSELAGE | $\underline{1}-\underline{2}-3-\underline{4}-5-\underline{6}-7-\underline{8}-9-\underline{10}-\underline{11}$ |

FLOW RATE:
(Proposed - 1.284 gal. per min.
(Theoretical - 1.4 gal. per min. (14 tips x .1 gpm/tip)
(Actual - 1.31 gal. per min.

EFFECTIVE SWATH WIDTH: 66'
PRESSURE IN SYSTEM DURING SPRAYING: Range 35# - 42#
AIRSPEED: 90 mph = Groundspeed AIRPORT LOCATION: Solon Springs, Douglas Co.
LEGAL DESCRIPTION OF TREATED BLOCKS: South end of Sec. 29, T43N, R13W
DATE OF APPLICATION: June 29, 1968
TIME OF SPRAY APPLICATION: START: 9:25 a.m. CDST FINISH: 9:55 a.m. CDST
NUMBER OF SWATHS FLOWN: 22.75 UNIFORM LENGTH: 1 mile
NUMBER OF 66 FOOT CHAINS PER SWATH: 80 TOTAL CHAINS FLOWN: 1,820
DIRECTION OF FLIGHT: E-W swaths. Started at North end of block
HEIGHT ABOVE CANOPY: 50'
WIND OR AIR MOVEMENT AT TIME OF SPRAYING: Variable during spray period. 3-5 mph with gusts to 6 or 7 at completion of application. Varied from S to W at start and to NW at finish.
TEMPERATURE: 19° C at start to 22° C at finish (66.2° F - 71.6° F) in field.
55° F at airport when plane was loaded
PRECIPITATION: None. Dew heavy at daybreak
OTHER NOTES: Matacil Concentrate contained 2.8# active per gal. Concentrate diluted 1:1 with Panasol or to 1.4# active/gal. 2 containers of Panasol had heavy precipitate and could not be used. Two other cans were clear. Heavy widespread ground fog conditions developed at spray site and surrounding area by 6:00 a.m. and delayed application.